U.S. Army Corps of Engineers

FINAL SUPPLEMENTAL RI REPORT

Volume I – Final Report

REMEDIAL INVESTIGATION/FEASIBILITY STUDY
ALABAMA ARMY AMMUNITION PLANT – AREA B
CHILDERSBURG, ALABAMA

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EXECUTIVE SUMMARY

This report documents the results of the Supplemental Remedial Investigation (RI) conducted by Science Applications International Corporation (SAIC) at Area B of the Alabama Army Ammunition Plant (ALAAP) located in Childersburg, Alabama. The ALAAP facility is a National Priorities List (NPL) site and was placed on the U.S. Department of Defense (DOD) Base Realignment and Closure (BRAC) list in 1988. Supplemental RI activities were conducted at 25 study areas, including 19 study areas identified during previous investigations and 6 additional sites identified during the Community Environmental Response Facilitation Act (CERFA) investigation (TETC 1994). The objectives of the present study were to fill data gaps from previous investigations and further define the presence, nature, and extent of environmental contamination resulting from the production of explosives by the U.S. Army during World War II. Baseline risk assessments were conducted for human health and ecological effects. The purpose of the risk assessments was to help determine whether any of the study areas or CERFA sites should be evaluated in a companion document, the Feasibility Study (FS) Report. The FS Report evaluates remedial action alternatives for study areas where remedial actions may be required.

The ALAAP facility was operated between 1942 and 1945 to produce nitrocellulose (NC), single-base smokeless powder, and nitroaromatic explosives (i.e., 2,4,6-trinitrotoluene [TNT], 2,4-dinitrotoluene [2,4-DNT], and 2,4,6-trinitrophenyl-methylnitramine [tetryl]). In addition, the plant also produced sulfuric and nitric acid, aniline, diphenylamine (DPA), oleum, sellite (sodium sulfite), and N,N-dimethylaniline. Since the plant was converted to standby status, various parcels have been excessed. Of the original 13,233 acres of land owned by the U.S. Army, 2,187 acres remain under U.S. Government control and are designated as Area B. This portion of ALAAP was investigated during this Supplemental RI.

A series of environmental studies and investigations have been conducted on ALAAP since the first comprehensive environmental assessment in 1978. Additional studies on Area B included an Environmental Survey (ESE 1981), a Confirmatory Environmental Survey (ESE 1983), an RI (ESE 1986), and a Supplemental RI (ESE 1993). These studies concluded that groundwater, soils, and sediments were impacted from the production of explosives and supporting chemicals during the active years of the installation. The Supplemental RI conducted by SAIC was designed to fill data gaps pertaining to the chemical nature and extent of environmental contamination.

In addition to investigations conducted at Area B of ALAAP, remediation of contaminated soil has occurred at four former manufacturing areas (Study Area 2 [Smokeless Powder Facility], Study Areas 6 and 7 [Southern and Northern TNT Manufacturing Areas], and Study Area 10-West [Tetryl Manufacturing Area]). Soil remediation also occurred at Study Area 16 (Flashing Ground), Study Area 17 (Propellant Shipping Area), and Study Area 19 (Lead Facility). Remediation of sediment has occurred within portions of a drainage ditch that received process wastewater (Study Area 21 [Red Water Ditch]). Remediation of a tar-like substance and contaminated sediment was conducted at Study Area 9 (Aniline Sludge Basin). A former landfill (Study Area 22

[Demolition Landfill]) has been capped to prevent future disturbance of buried material or infiltration. PCB-contaminated soils have been removed from several areas where downed utility poles were located on ALAAP – Area B. The U.S. Environmental Protection Agency (EPA) approved Interim Records of Decision (IRODs) to remediate the contaminated soil and sediment at these study areas or to prevent future migration of contaminants.

The present investigation was conducted in four phases (1, 2, 3, and 4A). The investigation consisted of field screening soil and sediment; sampling and analyzing surface soil, sediment, and surface water; drilling and sampling soil borings; sampling existing monitoring wells at Area B; and installing and sampling additional monitoring wells. Hydrogeologic investigations included groundwater and surface water elevation measurements and slug testing. In addition, bioassays were conducted and biota samples of crayfish, fish, and rabbit tissue were collected and used to evaluate the potential environmental impacts of contamination at Area B of ALAAP. Aerial and topographic surveying was completed to map Area B surface features.

Results from this Supplemental RI indicate that all environmental media, including groundwater, surface water, soil, and sediment, have been impacted to various degrees by previous activities at ALAAP. The contamination is characterized primarily by nitroaromatic compounds and metals associated with the production of explosives and the manufacturing of supporting chemicals.

A quantitative human health risk assessment was conducted for Area B. The risk assessment evaluated exposures to soil, groundwater, sediment, surface water, rabbit, and fish tissue under various land uses, including industrial, construction, recreational, and residential. In the risk assessment, a chemical was identified as a chemical of concern (COC) if it significantly contributed to a pathway that exceeded a 1×10^{-4} cancer risk or a hazard index (HI) of 1. COCs were identified for each land use scenario. For the most likely land uses (i.e., industrial and construction), human health COCs were identified for soil and groundwater, but not sediment or surface water. In soil, the most likely land use COCs were divided into three groups: metals, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs). Fourteen COCs in soil (five metals, six PAHs, and three PCBs) were identified for the industrial and construction land use scenarios. Twenty COCs in soil (seven metals, two explosives, eight PAHs, and three PCBs) were identified for the residential land use scenario, which is a more conservative and unlikely risk scenario. In groundwater, which was evaluated only under the residential land use scenario, the COCs consisted of seven explosives (or related substances), two PAHs, eight metals (including lead), two SVOCs, and two VOCs.

A quantitative ecological risk assessment was conducted for Area B that evaluated exposures to both terrestrial and aquatic receptors. The terrestrial receptors were immobile, soil dwelling organisms (vegetation and earthworms) and mobile, non-soil dwelling organisms (shrews, rabbits, woodcocks, deer, foxes, and hawks). The aquatic receptors were rooted and floating vegetation, crayfish, fish, heron, and mink. Because there were no pathways for air or groundwater, no ecological risk calculations were made for these media. A chemical was identified as a COC if

the ecological hazard quotient (HQ) exceeded 1. In soil, the ecological COCs (ecoCOCs) consisted of 14 metals and 2 organics (PCBs). The highest risk (quotients exceeding 100) were associated with aluminum and chromium at a few study areas. In sediment, the COCs consisted of eight metals and six organic chemicals. Risk quotients did not exceed 100 in sediment. In surface water, the COCs consisted of seven metals and one organic chemical. Risk quotients did not exceed 100 in surface water.

The groundwater underlying Area B contains frequently detected organic and inorganic constituents (i.e., explosives and metals) that are attributable to previous activities on ALAAP. Elevated concentrations of nitroaromatic constituents, including 2,4-DNT, 2,6-DNT, and TNT occurs in the southern portion of Area B between Study Area 17 and the Blending Tower Area (Study Area 18) and extending north toward Study Area 6. Another area of groundwater contamination occurs in the southwestern corner of Area B and is associated with elevated concentrations of 2,4-DNT and TNT. These wells are downgradient from the former smokeless powder manufacturing area at the Alliance Coosa Pines facility (formerly Kimberly-Clark Corporation).

Groundwater containing nitroaromatic compounds also is found at isolated well locations in Study Area 7, the Acid/Organic Manufacturing Area (Study Area 8), and Study Area 10. Due to preferential flow paths in the karst aquifer, some of these areas may reflect downgradient "slugs" of the larger contaminant areas or may be related to other localized contaminant sources across the installation.

Additional nitroaromatic compounds detected in the groundwater at Area B include 1,3,5-trinitrobenzene (1,3,5-TNB), 1,3-dinitrobenzene (1,3-DNB), nitrobenzene, and isomers of nitrotoluene. The nitroaromatic breakdown products 2-amino-4,6-dinitrotoluene (2-A-4,6-DNT) and 4-amino-2,6-dinitrotoluene (4-A-2,6-DNT) also were detected. Nitroaromatic compounds and lead were detected in bedrock wells. A precise source for the explosives is not currently known.

Trace concentrations of volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs) were detected during groundwater analyses, including 1,1,1-trichloroethane (1,1,1-TCA), trichloroethene (TCE), toluene, phenol, pentachlorophenol (PCP), carbon tetrachloride, chloroform, and PAHs. Several concentrations of organic chemicals exceed U.S. Environmental Protection Agency (EPA) maximum contaminant levels (MCLs), including carbon tetrachloride, PCP, bis-2(ethylhexyl)phthalate (B2EHP), and vinyl chloride.

The spatial distribution of lead concentrations in the groundwater at Area B was similar to the observed patterns for the nitroaromatic compounds, suggesting a common source area. Lead concentrations in Area B exceed the EPA action level (15 µg/L at the tap) for lead in groundwater.

In the area east of the groundwater divide, the groundwater in the vicinity of Study Areas 16 and 19 contains nitroaromatic compounds (2,4-DNT, TNT, and 2,6-DNT), metals, VOCs (acetone, toluene, 1,1,1-TCA, and xylene), and a variety of SVOCs.

Groundwater exposures were not evaluated for human health effects under the industrial land use scenario. Drinking water for Area B currently is supplied by the county water treatment plant, which would most likely continue under future industrial land use. However, the baseline risk assessment indicates that the risk to hypothetical residential users of the groundwater exceeds the risk-based limits established in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The risks are sufficiently high to indicate that any use of the untreated groundwater would result in risks above EPA target levels. Because of the elevated concentrations of nitroaromatic compounds and lead in the groundwater within Area B, additional investigations are underway to determine the extent of contaminant migration, the potential for risks to offsite receptors, and the feasibility of groundwater remediation. A separate report with recommendations addressing these issues relative to the groundwater contamination will be prepared at the conclusion of the ongoing investigations.

Results from Phase 1 of the Supplemental RI indicate that 2,4-DNT was the predominant explosive present in soils at ALAAP. However, since the initial phase (Phase 1) of sampling at ALAAP, an extensive amount of remediation for explosives and lead contamination has been conducted by Roy F. Weston and Environmental Chemical Corporation (ECC). Confirmatory sampling results from these excavations have been combined with the Supplemental RI sampling results and used in the risk assessments for ALAAP – Area B. The resulting risk assessments show that explosives are not human health COCs for the likely future land uses (i.e., industrial and construction) and are not ecoCOCs. Explosives are human health COCs for the most conservative land use (i.e., residential) at Study Area 2 (Smokeless Powder Facility), Study Area 7 (Northern TNT Manufacturing Area), and Study Area 16 (Flashing Ground). Remediation of explosives-contaminated soils was sufficient to reduce risks to acceptable levels for human receptors for the most likely future land use and for ecological receptors.

The results from the Supplemental RI for also indicate that lead is a human health COC in soils for both the most likely future land use (i.e., industrial and construction) and the most conservative land use (i.e., residential). Lead was identified as a human health COC for the most likely land use (i.e., industrial and construction) at Study Area 4 (Manhattan Project Area), Study Area 16 (Flashing Ground), and Study Area 22 (Demolition Landfill). Lead was identified as a human health COC for the most conservative land use (i.e., residential) at Study Area 8 (Acid/Organic Manufacturing Area) and Study Area 10 – West (Tetryl Manufacturing Area), in addition to the study areas listed above. A variety of other metals were identified as COCs in the soils throughout the ALAAP – Area B study areas.

Human health risk estimates for Study Area 16 (Flashing Ground) incorporated results from the Phase 1 Supplemental RI and excavation data from Roy F. Weston and ECC. The resulting risk assessments show that several areas of soil contamination remain in Study Area 16 where lead was identified as a COC for the most likely future land use. Arsenic, iron, lead, and a variety of PAHs and SVOCs were identified at Study Area 16 as COCs for the most conservative land use.

Based on the Phase 1 Supplemental RI and the recommendations presented in the Draft Final Feasibility Study (SAIC 1996b), a landfill cap has been placed over the Demolition Landfill (Study Area 22) to reduce infiltration and migration of contaminants present in the soils at this study area.

PCBs were detected in the surface soil near transformers located in Study Area 2 (Smokeless Powder Facility). Screening samples collected around all transformers and former transformer buildings identified a potential PCB source from two of the transformers. A sufficient number of screening samples were collected to fully characterize the vertical and horizontal extent of contamination. Laboratory samples collected from these areas verified the presence of PCBs. Excavation and disposal of the PCB contaminated soils has occurred since the Phase 1 Supplemental RI.

PAHs were identified as human health COCs in the soil for the industrial and construction land uses at Study Areas 2 and 22. PAHs are byproducts of combustion and many of the structures in Area B were demolished by burning. As stated above, Study Area 22 (Demolition Landfill) has been capped since the collection of soil samples during the Phase 1 Supplemental RI. PAHs were also identified as human health COCs in the soil for the residential land use at Study Areas 8 and 16.

Several metals were ecoCOCs in surface soil with HQs >1. For example, lead was detected in soils at concentrations resulting in HQs exceeding 1 at numerous study areas, including Study Areas 2, 3, 4, 6, 7, 8, 10 East, 10 West, 16, and 22; the Coke Oven; and the Pesticide and Fertilizer Storage Building. Aluminum also was detected in the surface soil at a number of study areas at concentrations that resulted in HQs > 1. These study areas included Study Areas 2, 4, 8, 16, 17, and 20; the Coke Oven; and the Pesticide and Fertilizer Storage Building. Study Areas 2, 3, 8, 16, 17, 18, 20, 22, and 25; the Coke Oven; and the Pesticide and Fertilizer Storage Building had four or more metal ecoCOCs with HQs >1.

Sediments sampled from surface water bodies, drainage channels, and ditches within Area B contain a variety of chemical constituents, including explosives, metals, VOCs, and SVOCs. Study Area 21 (Red Water Ditch) carried process wastewaters from the manufacturing areas and contained the most abundant number of contaminants (1,3,5-TNB, 2,4,6-TNT, 2,4-DNT, 2-A-4,6-DNT, 4-A-2,6-DNT, and tetryl; 17 metals above background concentrations; and various VOCs and SVOCs). Explosives were detected at low concentrations at various locations along the Red Water Ditch. The highest concentrations of metals were detected in the northern tributary to the Red Water Ditch, near Study Area 8 (Acid/Organic Manufacturing Area) and at locations below Study Area 5 (Red Water Storage Basin). In the human health risk assessment, the only COC identified was iron in the Study Area 9 (Aniline Sludge Basin) sediment under a residential land use scenario. None of the chemicals was identified as a COC under the future industrial or construction land use scenarios. Eight metals, acetone, and five PAHs were identified as ecoCOCs with HQs >1 in sediment at one or more study area.

Surface water bodies located at Area B of ALAAP, including Study Area 9 (Red Water Storage Basin), Study Area 21 (Red Water Ditch), Study Area 26 (Crossover Ditch), Study Area 27 (Beaver Pond Drainage System) and a marshy area north of Study Area 16 (Flashing Ground), contain a variety of metals at concentrations above background. Explosives (including 2,4-DNT, 2,6-DNT, 2,4,6-TNT, 2-A-4,6-DNT, 4-A-2,6-DNT, nitrobenzene, and isomers of nitrotoluene) were detected in the surface water within the Beaver Pond Drainage System. The source of explosives is attributed to the nearby TNT Manufacturing Areas. No COCs for human health (metals or explosives) were identified in surface water under any land use scenario. However, under the most conservative land use scenario (residential), COCs for ingesting fish were identified at two study areas: arsenic and Aroclor 1254 in fish from Study Area 21 (Red Water Ditch) and mercury in fish from Study Area 26 (Crossover Ditch). Seven metals and carbon disulfide were identified as ecoCOCs with HQs >1 in surface water at one or more study areas.

There were three types of biological measurements at ALAAP: bioassays, tissue concentrations, and field-observed effects. For bioassays, soil samples were used for earthworm growth and mortality and plant germination, sediment samples were used for sediment-dweller growth and mortality, and surface water samples were used for water-flea growth and mortality. Bioassay results were used directly to help confirm ecological risk and especially to establish ecological RGOs.

For tissue chemical analysis or contaminant body-burdens, rabbit (muscle), fish (muscle [fillets], remainders, and whole body), and crayfish (whole body) were analyzed. The rabbit and fish data were used in exposure equations involving fish and game consumption by humans. They were destined for use as biotransfer factors in exposure equations for ecological predators; however, because the factors were not substantially different from those found in literature compilations, the literature factors were used. On-site tissue concentration data were used to provide context. For example, pesticide concentrations were much higher in fish from background locations than in fish from study areas inside Area B. An explanation for this is that reference streams drain agricultural lands where pesticides have been and are being used while no farming or related activities have occurred at ALAAP for more than 50 years.

The principal field-observed effects were that populations of fish and wildlife did not seem similar from habitat to habitat and study area to study area. For example, it required much more effort to obtain fish in the lower Crossover Ditch than other similar places. In study areas near the facilities and especially along the berms of the Red Water Ditch, there were patches of soil where no germination occurred. This third type of biological measurement did not have the cause/effect relationships so well established with the bioassays. Regardless, all the on-site biological measurements supported or provided context and numbers for the ecological risk assessment.

The recommendations for further actions for soils, sediments, and surface water are summarized in **Tables ES-1** through **ES-3**. Recommendations are provided for both the likely future land use scenarios (i.e., industrial and construction) and the most conservative land use scenario (i.e., residential) based on human health risk estimates. The industrial and construction

scenarios are proposed as the most likely reuse alternative for Area B of ALAAP, according to a Site Management Plan prepared by the U.S. Army Environmental Center (USAEC) for ALAAP (USAEC 1995b). Recommendations for protection of the environment also are provided based on quantitative ecological risk assessments.

Remedial goal options (RGOs) are cleanup goals designed to be protective of human health and the environment and were calculated for the human health COCs and ecoCOCs. In accordance with EPA Region IV guidance, human health remedial goal options (HHRGOs) were calculated for each COC and for each land use. The HHRGOs are estimates of protective cleanup levels based on risk to human receptors and were developed using cancer target risks of 1×10^{-6}, 1×10^{-5}, and 1×10^{-4}, and using noncancer target HQs of 0.1, 1, and 3. This provides multiple RGOs for a given chemical.

The ecoRGOs are based on the above findings as well as the results from numerous site-specific bioassays and background measurements. Background provided a realistic RGO if other derived concentrations were lower than background. The resulting ecoRGOs were justified on the basis of: (1) ARARs, (2) toxicological effects-based calculations for soil dwelling organisms (plants and earthworms) and non-soil dwelling organisms (mammals and birds), (3) ALAAP-specific bioassay results, and (4) background measurements. EcoRGOs are protective of mobile non-soil dwellers and immobile soil dwellers at Area B.

The final assessment of the need for remediation at Area B will be made through risk management decisions. In deciding whether or not an area requires further action, risk managers consider many factors, such as the nature and extent of the contamination, magnitude of the risk estimate, and uncertainty associated with a risk estimate. These factors and their applicability to the Area B study areas will be discussed and evaluated in the FS. In addition, the HHRGOs, ecoRGOs, and ARARs will be presented and considered in the selection of the final cleanup levels. Integration of public comments, regulatory reviews, documented findings from investigations at Area B of ALAAP, and the Technical Review Committee (TRC) recommendations are used to reach the final decisions pertaining to further actions at the investigated sites. The decisions will be documented in the Final Record of Decision (ROD) for Area B of ALAAP.

Table ES-1. Recommendations for Soil
Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area No.	Study Area	Protection of Human Health		Protection of Ecological Resources[a]
		Likely Land Use (Industrial and Construction)	Most Conservative Land Use (Residential)	
2	Smokeless Powder Facility	Evaluate in FS.	Evaluate in FS.	Evaluate in FS.
3	Sanitary Landfill and Lead Facility	No further action.	Evaluate in FS.	Evaluate in FS.
4	Manhattan Project Area	Evaluate in FS.	Evaluate in FS.	Evaluate in FS.
6	Southern TNT Manufacturing Area	No further action. Site has been remediated.	No further action. Site has been remediated.	No further action[b]. Site has been remediated.
7	Northern TNT Manufacturing Area	No further action. Site has been remediated.	No further action[b]. Site has been remediated.	No further action[b]. Site has been remediated.
8	Acid/Organic Manufacturing Area	Evaluate in FS.	Evaluate in FS.	Evaluate in FS.
8	Acid/Organic Manufacturing Area – Test Pits	Evaluate in FS.	Evaluate in FS.	No further action.
10–East	Tetryl Manufacturing Area	Evaluate in FS.	Evaluate in FS.	Evaluate in FS.
10–West	Tetryl Manufacturing Area	No further action.	Evaluate in FS.	Evaluate in FS.
16	Flashing Ground	Evaluate in FS.	Evaluate in FS.	Evaluate in FS.
17	Propellant Shipping Area	Evaluate in FS.	Evaluate in FS.	Evaluate in FS.
18	Blending Tower Area	No further action.	Evaluate in FS.	Evaluate in FS.
19	Lead Facility	No further action.	Evaluate in FS.	No further action.
20	Rifle Powder Finishing Area	No further action.	Evaluate in FS.	Evaluate in FS.
22	Demolition Landfill	No further action. Landfill has been capped.	No further action. Landfill has been capped.	No further action. Landfill has been capped.
25	Storage Battery/Demolition Debris	Remove batteries and debris from hillside.	Remove batteries and debris from hillside. Evaluate COCs in FS.	Remove batteries and debris from hillside. Evaluate COCs in FS.
CERFA Site	Coke Oven (B6)	No further action.	Evaluate in FS.	Evaluate in FS.
CERFA Site	Downed Utility Poles with Transformers and Transformer Storage Building (PO)	No further action pending approval of the Closure Report for remediated soils.	No further action pending approval of the Closure Report for remediated soils.	No further action pending approval of the Closure Report for remediated soils.
CERFA Site	USTs and Gas Station (US and GS)	No further action	Evaluate in FS.	No further action.
CERFA Site	Fertilizer and Pesticide Storage Building (PS)	Evaluate in FS.	Evaluate in FS.	Evaluate in FS.

[a] Recommendations are based on ecoCOCs with HQ >1.

[b] Risk assessment results show COCs. However, site has been remediated.

Table ES-2. Recommendations for Sediment Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area No.	Study Area	Protection of Human Health		Protection of Ecological Resources[a]
		Likely Land Use (Industrial and Construction)	Most Conservative Land Use (Residential)	
5	Red Water Storage Basin	No further action.	No further action.	No further action.
9	Aniline Sludge Basin – Sediment	No further action.	Evaluate sediment in FS.	Evaluate sediment in FS.
9	Aniline Sludge Basin – Tar	No further action.	No further action.	No further action.
9	Aniline Sludge Basin – Sediments Beneath Tar	No further action.	No further action.	No further action.
16	Flashing Ground	No further action.	No further action.	No further action.
21	Red Water Ditch	No further action.	No further action.	Evaluate sediment in FS.
26	Crossover Ditch	No further action.	No further action.	Evaluate sediment in FS.
27	Beaver Pond Drainage System	No further action.	No further action.	Evaluate sediment in FS.
Talladega Creek		No further action.	No further action.	No further action[b].
Coosa River		No further action.	No further action.	No further action[b].

[a] Recommendations are based on ecoCOCs with HQ >1.

[b] Although risk assessment results show COCs, no further action is recommended in this Supplemental RI/FS. This area is being evaluated as part of a separate groundwater investigation.

Table ES-3. Recommendations for Surface Water Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area No.	Study Area	Protection of Human Health		Protection of Ecological Resources[a]
		Likely Land Use (Industrial and Construction)	Most Conservative Land Use (Residential)	
9	Aniline Sludge Basin	No further action.	No further action.	Evaluate in FS.
16	Flashing Ground	No further action.	No further action.	Evaluate in FS.
21	Red Water Ditch	No further action.	Evaluate in FS based on COCs in fish tissue.	Evaluate in FS.
26	Crossover Ditch	No further action.	Evaluate in FS based on COCs in fish tissue.	Evaluate in FS.
27	Beaver Pond Drainage System	No further action.	No further action.	Evaluate in FS.
Talladega Creek		No further action.	No further action.	No further action.
Coosa River		No further action.	No further action.	No further action[b].

[a] Recommendations are based on ecoCOCs with HQ >1.

[b] Although risk assessment results show COCs, no further action is recommended in this Supplemental RI/FS. This area is being evaluated as part of a separate groundwater investigation.

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1. INTRODUCTION

This report documents the results of the Supplemental Remedial Investigation (RI) conducted by Science Applications International Corporation (SAIC) at Area B on the Alabama Army Ammunition Plant (ALAAP) located in Childersburg, Alabama. The ALAAP facility is a National Priorities List (NPL) site and was investigated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Environmental Policy Act (NEPA) to provide a response to potential environmental contamination caused by previous site usage. The investigation is the second supplemental study of Area B conducted to identify and delineate environmental contamination in the former manufacturing, processing, storage, and shipping areas on the ALAAP facility. The results of the present investigations were used in conjunction with historical site data to complete a Feasibility Study (FS), which presents alternatives and recommendations for the remediation of environmentally detrimental areas identified during this investigation. This Supplemental RI was conducted by SAIC in four phases between 1994 and 1997 at the request of the U.S. Army Environmental Center (USAEC) Base Realignment and Closure (BRAC) Division pursuant to Contract DAAA15-91-D-0017, Delivery Order DA12. The fourth phase of investigations is currently underway and is focused specifically on groundwater contamination present within Area B. The Phase 4 groundwater investigations are being conducted for the U.S. Army Corps of Engineers (USACE), Mobile District under Contract DACA21-95-D-0022 and results will be presented in a separate report. Soil, sediment, and tar-like material were sampled from two study areas during the Phase 4 investigations and the results are presented in this report. The following sections describe the purpose, scope, and objectives of the current investigation, provide historical and regulatory background for the facility, and summarize previous investigations conducted at the study areas.

1.1 PURPOSE AND SCOPE

Supplemental RI activities for Area B were conducted at 25 study areas, including 19 sites identified during previous investigations and 6 additional areas identified during the Community Environmental Response Facilitation Act (CERFA) inspection (TETC 1994). Several of the study areas along the southern facility boundary had not been investigated previously. The objectives of the present study were to investigate the presence, nature, and extent of potential environmental contamination resulting from the production of explosives by the U.S. Army during World War II. The investigations included assessments of the sources of potential contamination, delineation of the areal extent of detected contamination, detailed geologic and hydrogeologic characterization of the site, and assessment of potential ecological and human health risks associated with the contaminants. The investigated study areas are presented in **Table 1-1** and include nine manufacturing areas, nine waste disposal areas or ditches (e.g., landfills, burning grounds, or basins), and one shipping area. The CERFA study areas include a coke oven, a transformer storage building and several locations with downed transformer utility poles, three former underground storage tank (UST) sites, a fertilizer and pesticide storage building, and a former gas station. The

Table 1-1. Sites Identified for the Supplemental Remedial Investigation at Area B Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area No.	Study Area	Manufacturing Area	Shipping Area	Other Area
2	Smokeless Powder Facility	✓		
3	Sanitary Landfill and Lead Facility			✓
4	Manhattan Project Area	✓		
5	Red Water Storage Basin			✓
6	Southern TNT Manufacturing Area	✓		
7	Northern TNT Manufacturing Area	✓		
8	Acid/Organic Manufacturing Area	✓		
9	Aniline Sludge Basin			✓
10	Tetryl Manufacturing Area	✓		
16	Flashing Ground			✓
17	Propellant Shipping Area		✓	
18	Blending Tower Area	✓		
19	Lead Facility	✓		
20	Rifle Powder Finishing Area	✓		
21	Red Water Ditch			✓
22	Demolition Landfill			✓
25	Storage Battery/Demolition Debris			✓
26	Crossover Ditch			✓
27	Beaver Pond Drainage System			✓
31, 32, TC4A, TC4B	Stockpile Soils			
N/A	Industrial Sewerline System			
CERFA Site	Building 6 – Coke Oven			
CERFA Site	Transformer Storage Building			
CERFA Site	Downed Utility Poles with Transformers			
CERFA Site	Underground Storage Tanks			
CERFA Site	Fertilizer and Pesticide Storage			
CERFA Site	Gas Station			

N/A – Not Applicable

Supplemental RI was conducted to address data deficiencies identified by the U.S. Environmental Protection Agency (EPA) and the Alabama Department of Environmental Management (ADEM).

The first phase of the Supplemental RI for Area B (referred to as Phase 1) was conducted from September 1994 through August 1995; the majority of the investigation was implemented from March through August 1995. The results of the Phase 1 investigation were documented in the Draft Final RI Report for ALAAP – Area B (SAIC 1996a). As a result of comments received from ADEM and data gaps that were identified, SAIC conducted three additional phases of Supplemental RI activities in Area B. Phase 2 was implemented from May to July 1996 and Phase 3 was implemented from December 1996 to January 1997. Sampling and analysis of soil, sediment, and waste material from two study areas were conducted as part of Phase 4 in October to December 1997 and the results also are presented in this report. A revised (i.e., Version 2) Draft Final RI Report was prepared in April 1999 and presented the results of the four phases of Supplemental RI activities and conclusions and recommendations based on the results (SAIC 1999). Comments were received from the following agencies and organizations: U.S. Environmental Protection Agency (EPA) Region IV, Alabama Department of Environmental Management (ADEM), U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM), and U.S. Army Corps of Engineers Waterway Experiment Station (USACE/WES). The comments have been addressed and changes incorporated into this Final RI Report. Written responses to each of the comments received are provided in Appendix P to this report.

1.2 OBJECTIVES

The Phase 1 RI activities followed the site-specific Sampling and Analysis Plan (SAP)/Work Plan (SAIC 1995a), Quality Assurance Project Plan (QAPP) (SAIC 1995b), and Health and Safety Plan (HASP) (SAIC 1995c). Addenda to the SAP/Work Plan, QAPP, and HASP were prepared prior to implementation of RI Phases 2, 3, and 4 (SAIC June 1996; SAIC November 1996; SAIC October 1997). RI activities were conducted using EPA and USAEC guidance, including *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA 1988a); *Data Quality Objectives for Remedial Response Activities* (EPA 1987c); *Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Branch* (EPA 1991d); *Geotechnical Requirements for Drilling, Monitor Wells, Data Acquisition, and Reports* (USATHAMA 1987); and the *Quality Assurance Program* (USATHAMA 1990). Additional regulatory guidance specific to the human health and ecological risk assessments is cited in the associated sections of this report.

The specific objectives of the Supplemental RI at ALAAP were to:

- Delineate the presence, chemical nature, concentration, and distribution of identified contaminants
- Evaluate the potential for contaminant release and migration
- Conduct quantitative human health and ecological risk assessments

- Prepare recommendations for remedial actions to mitigate quantified contamination that poses an unacceptable risk to human or ecological receptors
- Evaluate the necessity for immediate response actions
- Develop sufficient information to prepare a Record of Decision (ROD) for Area B.

1.3 REPORT ORGANIZATION

The RI Report is structured in accordance with outlines provided in *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA 1988a). The contents of the report by section are presented below:

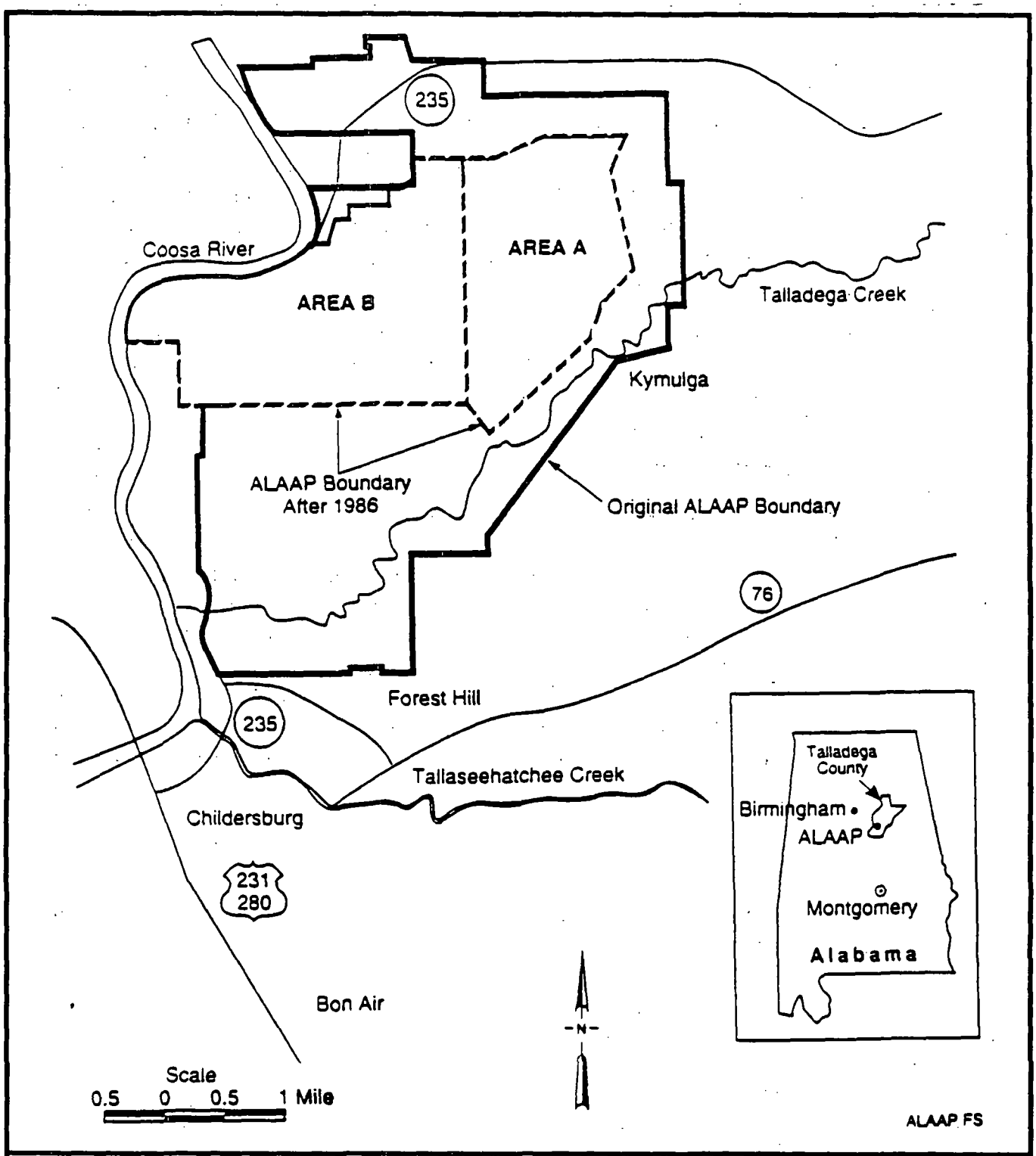
- ***Section 1. Introduction***—The remainder of this section summarizes the site background and history, describes processes and waste disposal history, summarizes previous studies and investigations, describes each study area under investigation, and discusses current site activities.
- ***Section 2. Environmental Setting***—This section presents the geographic and environmental setting of ALAAP – Area B. Physiography and topography, climate, demographics and land use, geology, soil, hydrogeology, hydrology, vegetation and habitats, and wildlife are discussed.
- ***Section 3. Methods and Procedures***—The rationale for all four phases of the field investigation activities, methodologies, and sampling procedures is presented in this section. The section discusses methodologies for monitoring well inventory; aerial and topographic surveying; field screening; geological/geotechnical investigations; groundwater, surface water, and sediment sampling; hydrogeological and ecological investigations; and disposition of investigation-derived waste (IDW).
- ***Section 4. Results of Field Investigations***—This section provides a framework for understanding the nature and extent of contamination by first discussing the site-specific geology and hydrogeology of ALAAP – Area B. An assessment of data quality and the identification of site-related contaminants for all environmental media are provided. Discussions of the nature and extent of site-related contaminants in groundwater, soil, surface water, sediment, and biota are included.
- ***Section 5. Chemical Fate and Transport***—This section discusses the physical and chemical properties of the site-related contaminants and their expected fate and transport in soil, groundwater, surface water, and sediment. A conceptual site model for Area B also is presented that depicts the physiography and interaction of the surface water, soil, and groundwater. An explanation of the approach for the fate and transport analysis, the modeling conducted, and estimated uncertainty in the approach is provided.
- ***Section 6. Human Health Risk Assessment***—This section presents the results of the human health risk assessment, including the methodology, identification of chemicals of

potential concern (COPCs), exposure assessment, toxicity assessment, a risk characterization that identifies the chemicals of concern (COCs), the development of remedial goal options (RGOs), and an evaluation of the uncertainty in the assessment.

- ***Section 7. Ecological Risk Assessment***—This section presents the results of the ecological risk assessment, including the methodology, identification of chemicals of potential ecological concern (COPECs), exposure assessment, toxicity assessment, a risk characterization that identifies the COCs, the development of RGOs, and an evaluation of the uncertainty in the assessment.
- ***Section 8. Summary and Conclusions***—This section presents the recommendations and conclusions for each study area and lists the COCs for each media that will be used in the accompanying FS.
- ***Section 9. References***—This section lists the references that were used during the preparation of this report.
- ***Appendices***—The appendices to the report provide supporting information and data for the following activities: monitoring well inventory, land surveying, field screening, geotechnical investigations, hydrogeologic investigations, ecological surveys and investigations, data quality assessment, contaminant fate and transport modeling, and the human health and ecological risk assessments. The appendices also provide soil boring logs, monitoring well logs and construction diagrams, summary statistics for comparison of site data to background, and summary data tables for laboratory analytical results. Comments received from reviewing agencies and organizations on the Draft Final (Version 2) RI Report and approved responses to the comments are also provided in an appendix.

1.4 SITE BACKGROUND

The ALAAP facility is located in Talladega County, Alabama, approximately 4 miles north of the town of Childersburg and 40 miles southeast of the city of Birmingham. The plant was established in 1941 on 13,233 acres of land near the junction of Talladega Creek and the Coosa River (**Figure 1-1**). The original mission of ALAAP was to manufacture trinitrotoluene (TNT), dinitrotoluene (DNT), 2,4,6-trinitrophenyl methylnitramine (tetryl), and single-base smokeless powder for cannon and small arms in support of World War II efforts. The plant also produced the necessary supporting chemicals for the manufacturing operations, including nitric and sulfuric acids. Much of the original site was cleared when the facility was constructed in 1941. However, 3,411 acres of controlled pine forest have been planted in Area A since the cessation of operations in 1973. Logging operations have been allowed in Area A and throughout Area B since that time.



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CHILDERSBURG, ALABAMA

ALAAP Location Map

Figure No.	Project No.	File Name	Date
1-1	01-0827-03-8178-045	99015\DWGS\E42F1-1	03-31-99

1.4.1 Facility History

The ALAAP facility was operated by the EI duPont Company as a Government-owned/ contractor-operated (GOCO) facility during World War II with the intent of producing nitro-cellulose (NC), single-base smokeless powder, and nitroaromatic explosives (i.e., TNT, DNT, and tetryl). The plant was designed to manufacture 400,000 pounds of TNT; 30,000 pounds of DNT; and 36,000 pounds of tetryl on a daily basis. The plant's peak monthly production of the nitroaromatic explosives was 15.6 million pounds of NC in October 1942, 21.8 million pounds of TNT in April 1945, and 2.4 million pounds of tetryl in March 1945 (DA 1978). **Figure 1-2** shows the original facility layout for the manufacturing, shipping, and storage areas.

In addition to the manufacture of propellants and explosives, the plant produced sulfuric and nitric acid, aniline, diphenylamine (DPA), oleum (40 percent sulfur trioxide and sulfuric acid), sellite (sodium sulfite), and N,N-dimethylaniline. Spent acids were recycled and unrecoverable wastes resulting from these operations were disposed of onsite by discharge to an unlined ditch (DA 1978). The acid facility was leased to Tennessee Copper Corporation between 1947 and 1966 for the manufacture of acids and organic compounds on the site. Average daily production of oleum and sellite at ALAAP during its operation was 400 and 15 tons, respectively. In August 1945, the plant reverted to a standby status and the Government began excessing property.

Between 1949 and 1971, the Beaunit Corporation, an affiliate of El Paso Natural Gas, manufactured rayon in a leased area north of Area B (see Figure 1-2). In January 1954, the Government entered into a contract with the Liberty Powder Defense Corporation, a subsidiary of Olin Mathieson Chemical Corporation, in an effort to rehabilitate the plant. The contract provided for maintenance and consultant services in connection with the plant rehabilitation. Rehabilitation was initiated in April 1955, but was halted in October 1957 with only 75 percent of the rehabilitation complete. The plant was maintained in various stages of standby status until the early 1970s.

In 1973, the U.S. Army released the ALAAP facility to the General Services Administration (GSA) so that it could be sold. However, GSA declined to accept 1,620 acres of the former manufacturing area, part of what is now designated as Area B, because the area could not be certified free from contamination. Beginning in 1973, a controlled burning program was implemented by the U.S. Army to destroy explosives residues in the former industrial and storage areas. Nearly all of the buildings that were components of the explosives manufacturing facilities and the acid and organic chemical manufacturing facilities were burned. Sewers and underground utilities were left intact (ESE 1981).

The areas of ALAAP that were assessed by GSA in 1973 to be uncontaminated comprise the GSA Area. In 1977, a 1,354-acre parcel in the GSA Area containing the former NC manufacturing area, the smokeless powder manufacturing area, and 247 associated buildings was sold to Kimberly-Clark Corporation. In the same year, the U.S. Army leased back 291 acres within the GSA Area from Kimberly-Clark so that the area could be decontaminated, the manufacturing

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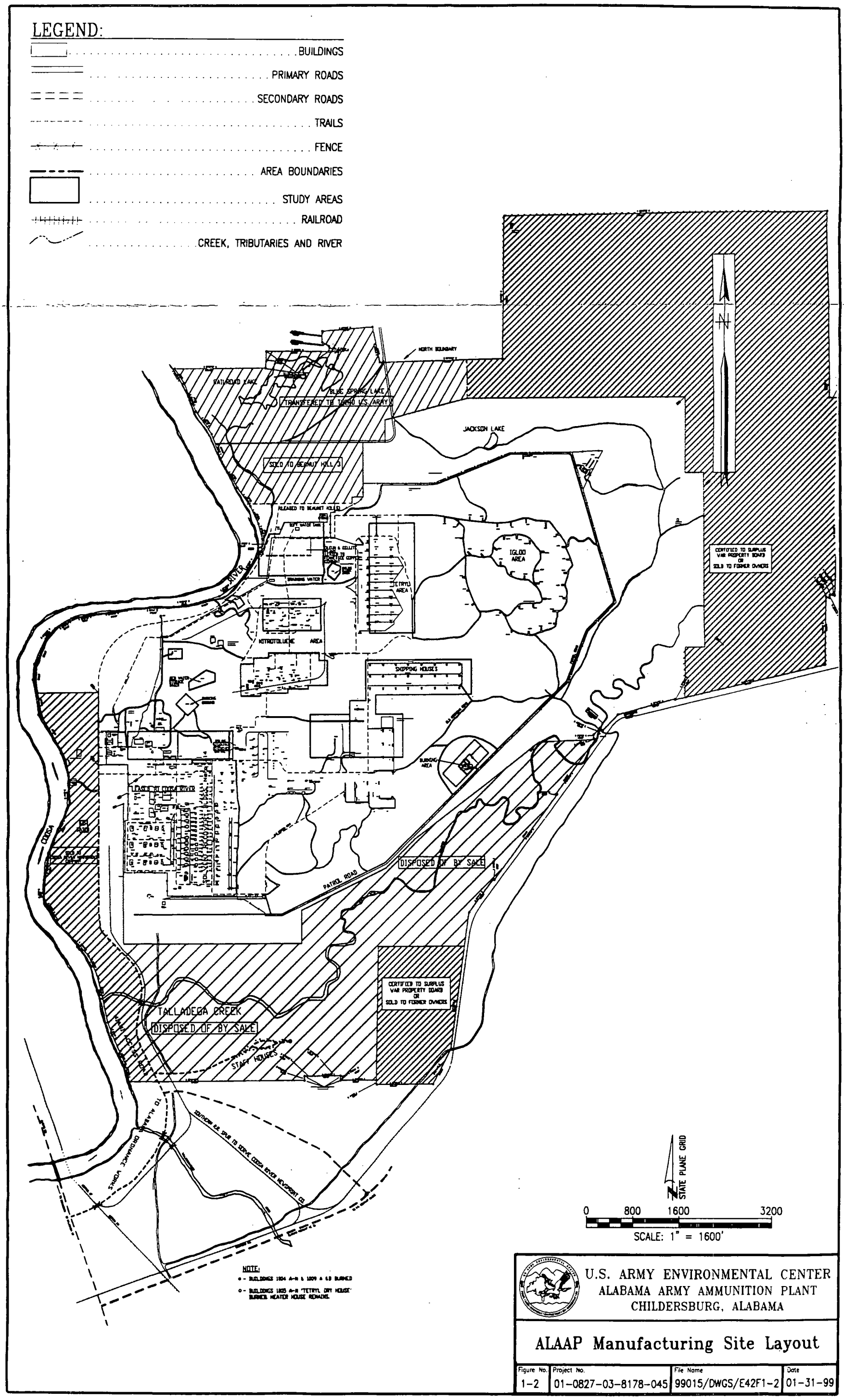

LEGEND:
BUILDINGS
PRIMARY ROADS
SECONDARY ROADS
TRAILS
FENCE
AREA BOUNDARIES
STUDY AREAS
RAILROAD
CREEK, TRIBUTARIES AND RIVER
NORTH BOUNDARY
RAILROAD LAKE
BLUE SPRING LAKE
TRANSFERED TO TOKYO U.S. ARMY
JACKSON LAKE
SOLD TO BEAUMUT HILL 3
IGLOO AREA
CONTOLED TO SURPLUS VAR PROPERTY BOARD OR SOLD TO FORMER OWNERS
NITROTOLUENE AREA
SKIPPING HOUSES
BURNING AREA
EAST FORK RIVER
COOSA RIVER
PATROL ROAD
DISPOSED OF BY SALE
TALLADEGA CREEK
DISPOSED OF BY SALE
CERTIFIED TO SURPLUS VAR PROPERTY BOARD OR SOLD TO FORMER OWNERS
STAFF HOUSES
TO ALABAMA ORDNANCE WORKS
SOUTHERN R.R. SPUR TO SEPAC CREEK RIVER NEWSPORT CO.
NOTE:
STATE PLANE GRID
0 800 1600 3200
SCALE: 1" = 1600'
U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA
ALAAP Manufacturing Site Layout
Figure No. 1-2
Project No. 01-0827-03-8178-045
File Name 99015/DWGS/E42F1-2
Date 01-31-99

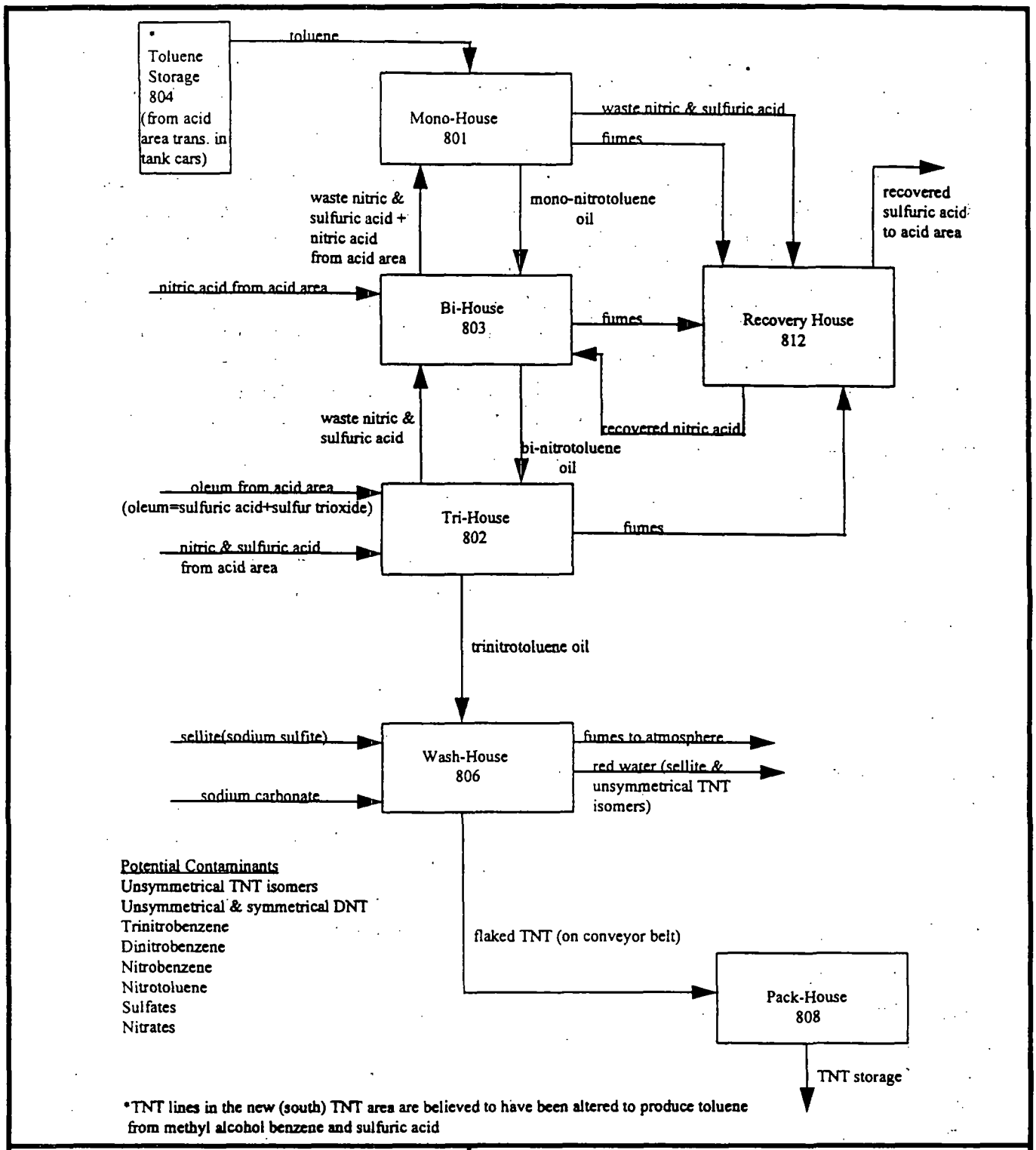
equipment removed, and the buildings razed. These areas comprise the Leaseback Area. One hundred and fifty-five additional buildings used primarily for explosives storage were left intact (ESE 1981).

By 1981, the facility had been divided into Area A (2,714 acres) to the east, containing the former storage area and GSA Area still under U.S. Government control, and Area B (2,187 acres), consisting of the former manufacturing (industrial) area (see Figure 1-2). In 1988, the Secretary of Defense recommended that the ALAAP facility be closed and placed it on the U.S. Department of Defense (DOD) BRAC 88 list. Area A was auctioned in May 1990 to private buyers who currently use the properties for logging and as hunting grounds. Area B remains under U.S. Army control in caretaker status and is bounded by Little Blue Creek to the north, the Coosa River to the west, and Talladega Creek and a pulp mill to the south. The facility was proposed for inclusion on the NPL by EPA in 1984 and was included on the list in 1987. The Area A portion of the ALAAP facility is currently in the process of being deleted from the NPL.

1.4.2 Manufacturing Processes and Waste Disposal History

Area B supported several explosives manufacturing operations, including the production of TNT, DNT, tetryl, acid, and other support chemicals. Powdered metals, such as barium, aluminum, manganese, magnesium, and lead, typically were used as additives during the production and manufacturing of explosives, explosives powder, and ammunition during World War II to increase their effectiveness (Federoff et al. 1960). The use of lead is particularly pervasive in production processes for explosives (e.g., nitrators, dying pans, and bearing metal), ammunition (e.g., bullets, shrapnel balls and shot, and preparation of oxides and salts for explosives mixtures) and TNT (typically uses an initiator made of lead or lead azide). No information is available on the specific use of metals during the production of explosives, ammunition, and TNT at ALAAP. However, because of the extensive explosive, ammunition, and TNT production activities at ALAAP during World War II, it is possible that some of these metals may have been used in the respective manufacturing processes. The following paragraphs describe the manufacturing processes that were used during the production of these explosives and associated chemicals.

Trinitrotoluene—TNT was produced by the successive nitration of toluene in four production lines in the Southern TNT Manufacturing Area (Study Area 6) and from four production lines in the Northern TNT Manufacturing Area (Study Area 7). **Figure 1-3** is a generalized flow diagram of a TNT production line at ALAAP. A critical aspect of the nitration was the circulation of water through cooling coils to control the process temperature. Nitric and sulfuric acids were transported to the two TNT manufacturing areas from the Acid/Organic Manufacturing Area (Study Area 8). Acids recovered from the TNT process were transported back to the Acid/Organic Manufacturing Area for separation. Sellite (sodium sulfite) and sodium carbonate (soda ash) were used in the TNT manufacturing process to neutralize the tri-nitrated oil and remove unsymmetrical TNT isomers. The product of the combination of sellite and unsymmetrical TNT isomers is called "red water." After the neutralization and purification process, the molten TNT was hardened,



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TNT Production Line

Figure No.	Project No.	File Name	Date
1-3	01-0827-03-8178-045	99015\DWGS\E42F1-3	03-31-99

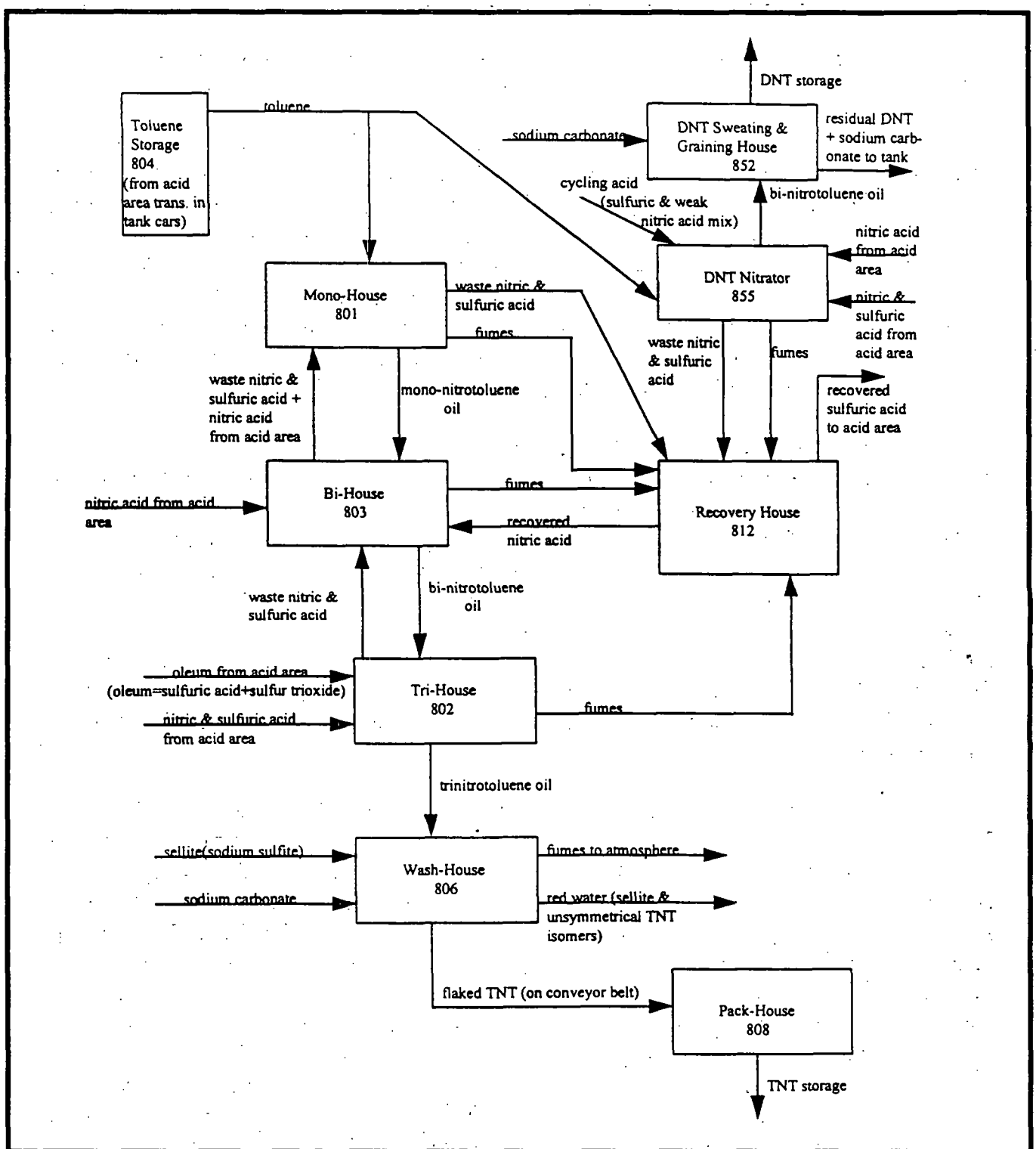
shaved, boxed, and stored. A recovery house was located at each TNT line to circulate and separate acids and fumes originating from the nitration houses.

The four TNT production lines in the Southern TNT Manufacturing Area were modified in 1943 to incorporate toluene manufacturing. However, during the 1954-57 rehabilitation period, Olin Mathieson Chemical Corporation returned three of the TNT lines to their original condition (DA 1978). Although information describing the methods of toluene production at ALAAP is not available, toluene likely was produced by combining methyl alcohol, benzene, and sulfuric acid in a Friedel-Crafts reaction. The majority of the wastes generated from the eight TNT production lines associated with the northern and southern manufacturing areas were piped to the Red Water Ditch (Study Area 21). An unknown amount of liquid waste from the Southern TNT Manufacturing Area was discharged to the Red Water Storage Basin (Study Area 5).

Dinitrotoluene—Only one DNT production line was constructed at ALAAP. This line was operated in conjunction with a TNT production line in the Northern TNT Manufacturing Area. **Figure 1-4** presents a generalized TNT/DNT production flow diagram. DNT was produced in a similar manner to TNT; however, the process involved only two nitration steps. Sodium carbonate was the only compound added to neutralize the bi-nitrotoluene oil. The residual DNT and sodium carbonate mixture was drawn off in a catch tank system. The neutralized DNT was pumped by air pressure into a DNT storage tank where it was dried, chopped, boxed, and stored. The recovery house used in the TNT production line also was used to recover fumes and waste acid from the DNT production line. Waste from the DNT production line was directed to the Red Water Ditch. The fate of the wastes collected in the catch tank system is uncertain, although it is likely that the mixture probably was directed to the Red Water Ditch.

Tetryl—Twelve tetryl manufacturing lines were located at the ALAAP Tetryl Manufacturing Facility (Study Area 10). **Figure 1-5** is a generalized production flow diagram of a tetryl production line at ALAAP. Tetryl was produced in a two-step process. The first step involved sulfonating N,N-dimethylaniline using N,N-dimethylaniline and sulfuric acid that was transported from the Acid/Organic Manufacturing Area to the sulfonating house at the Tetryl Manufacturing Area. The resulting intermediate compound, dimethylaniline sulfate (DMAS), then was nitrated in the second step of the process using a nitric and sulfuric acid mixture obtained from the Acid/Organic Manufacturing Area. Sodium carbonate was used to neutralize the resulting tetryl. Tetryl was refined by dispersing steam through a mixture of tetryl, acetone, and water. The refined tetryl was air dried, boxed, and stored. This refining process removed intermediate byproducts, which then were directed to the Red Water Ditch. Waste acids and fumes were directed to a recovery house, while residual tetryl and sodium carbonate were directed to the Red Water Ditch.

Acids/Organics—Acids and supporting organics were produced in the Acid/Organic Manufacturing Area (Study Area 8). Oleum (40 percent sulfur trioxide and sulfuric acid) and sellite (sodium sulfite) were derived from the burning of sulfur. **Figure 1-6** shows a generalized production flow diagram for the acids. The sulfur burn pit produced the necessary sulfur dioxide



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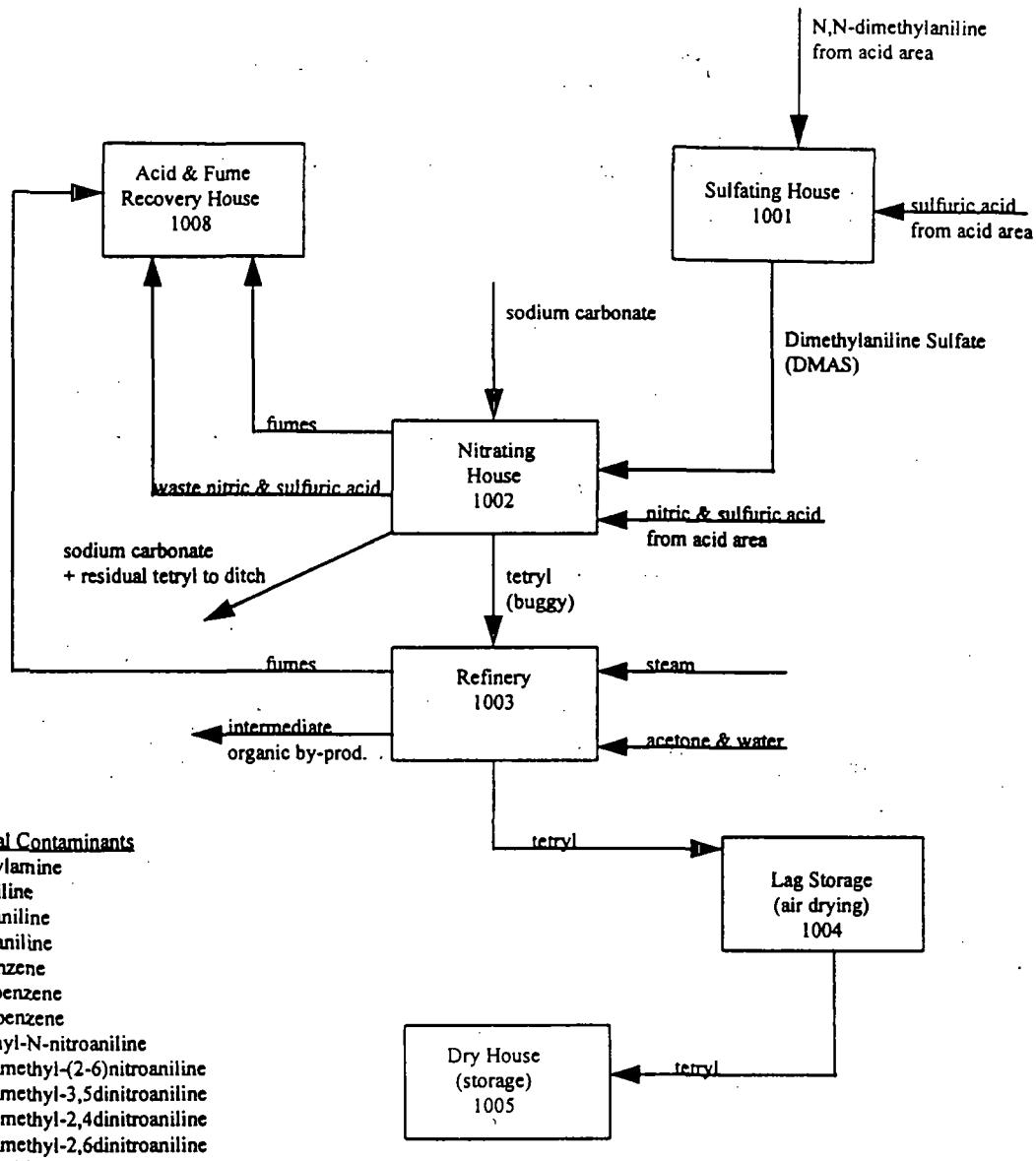
TNT/DNT Production Line
(North TNT Area 7)

Figure No.	Project No.	File Name	Date
1-4	01-0827-03-8178-045	99015\DWGS\E42F1-4	03-31-99



Potential Contaminants
diphenylamine
nitroaniline
dinitroaniline
trinitroaniline
nitrobenzene
dinitrobenzene
trinitrobenzene
N-Methyl-N-nitroaniline
N,N-Dimethyl-(2-6)nitroaniline
N,N-Dimethyl-3,5dinitroaniline
N,N-Dimethyl-2,4dinitroaniline
N,N-Dimethyl-2,6dinitroaniline
N-Methyl-N,2dinitroaniline
N-Methyl-N,3dinitroaniline
N-Methyl-N,4dinitroaniline
N,N-Dimethyl-2,4,6trinitroaniline
N-Methyl-N,2,4trinitroaniline
N-Methyl-N,2,6trinitroaniline
N-Methyl-N,2,5trinitroaniline
N-Methyl-N,3,6trinitroaniline
N-Methyl-N,3,5trinitroaniline
unsymmetrical tetryl (N-Methyl-X,X,X,X tetranitroaniline)
xylidine (6 isomers of dimethylaniline)

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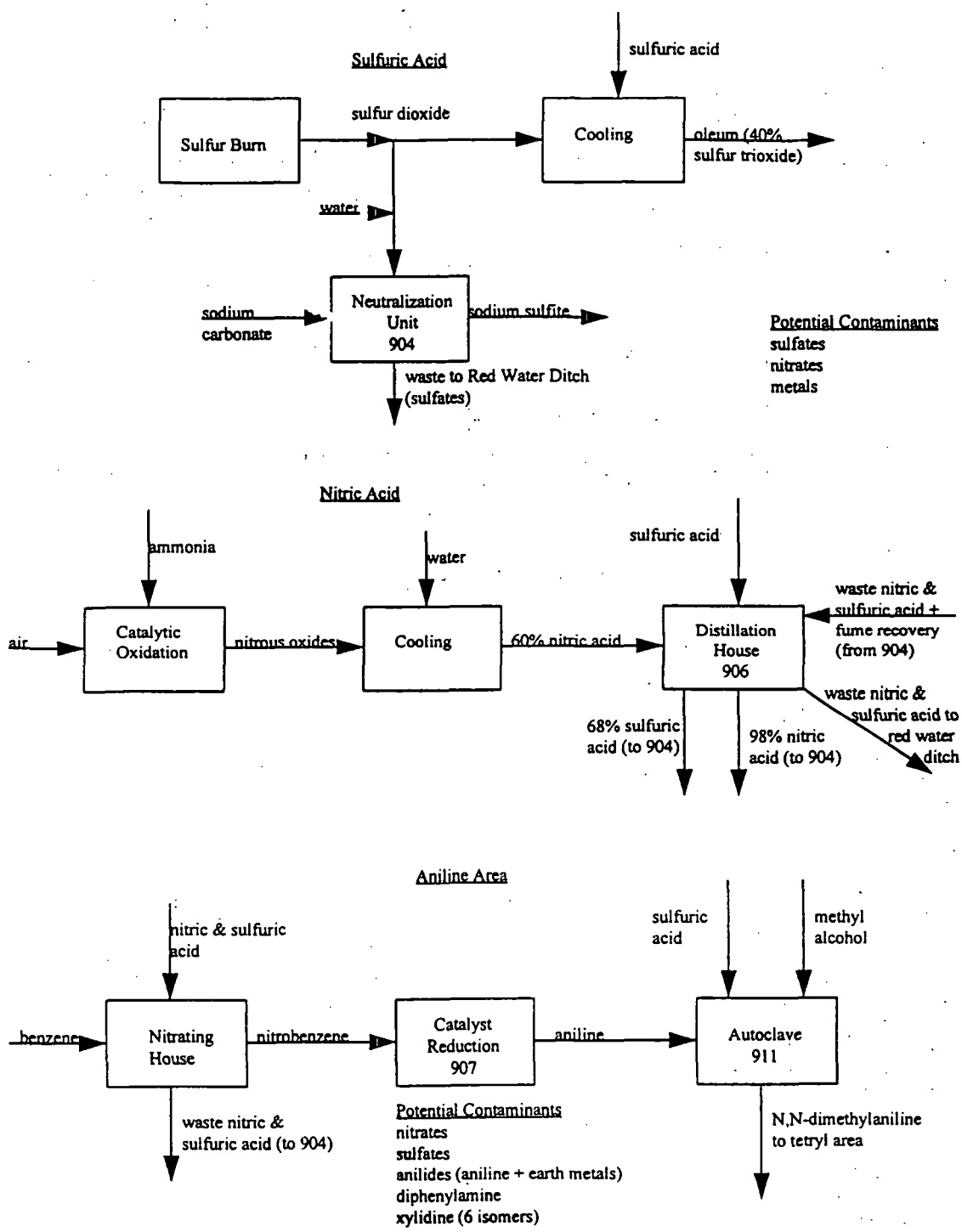
Tetryl Production Line

Figure No.	Project No.	File Name	Date
1-5	01-0827-03-8178-045	99015\DWGS\E42F1-5	03-31-99



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CHILDERSBURG, ALABAMA

Acid Area Production Line

Figure No.	Project No.	File Name	Date
1-6	01-0827-03-8178-045	99015\DWGS\E42F1-6	03-31-99

and oleum was produced by cooling the sulfur dioxide with sulfuric acid. Sellite was produced by combining the sulfur dioxide with water and then adding sodium carbonate. The resulting sulfate waste from these reactions was directed to the Red Water Ditch.

Nitric acid was produced by allowing air oxidation of ammonia to produce nitrous oxides. The resulting nitrous oxides then were cooled and the water was added to produce 60 percent nitric acid. The acid then was distilled with sulfuric acid to produce 98 percent nitric acid and 68 percent sulfuric acid. The concentrated acids then were directed to Building 904, where they were separated and distributed to the necessary operations. Waste acids from the recovery houses were directed to the distillation process to recover them for further use. Unrecoverable waste acid was directed to the Red Water Ditch.

N,N-Dimethylaniline used to support the manufacture of tetryl also was produced in the Acid/Organic Manufacturing Area. N,N-Dimethylaniline production began with the addition of nitric and sulfuric acids to benzene to produce nitrobenzene. Catalytic reduction of nitrobenzene yielded aniline. The aniline then was treated with a mixture of sulfuric acid and methyl alcohol under high pressure and temperature to yield N,N-dimethylaniline. Waste acids were recovered and recirculated throughout the process. Waste liquid from this process was sent to the Red Water Ditch.

1.4.3 Previous Studies and Investigations

Previous environmental studies and investigations conducted at the ALAAP facility are summarized in **Table 1-2** and described below.

The U.S Army conducted the first comprehensive environmental assessment at ALAAP in 1978 (DA 1978). The investigation, consisting of a records evaluation and a site inspection, summarized facility operations and manufacturing processes, and identified sites (including buildings) throughout the facility that exhibited visible contamination or presented the potential for contamination of the environment. The records search concluded that facility areas are potentially contaminated with chemical and explosives manufacturing wastes, including TNT, DNT, tetryl, smokeless powders, acids/organic compounds, and metals, and that the potential exists for contaminated surface runoff.

Environmental Science and Engineering (ESE) conducted an Environmental Survey (later referred to as the Exploratory Survey) (ESE 1981) and a Confirmatory Environmental Survey (ESE 1983) of the ALAAP facility under contract to the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) between 1979 and 1983. Contamination by explosives residues in soil, sediment, and shallow groundwater in the manufacturing areas on ALAAP was noted in the Exploratory Survey report (ESE 1981). The Confirmatory Environmental Survey (ESE 1983) was conducted to verify the presence of environmental contamination, investigate the magnitude and extent of the releases at the facility, and assess potential environmental and human health impacts. The Confirmatory Environmental Survey (ESE 1983) evaluated eight sites in Area B, including the

Table 1-2. Significant Previous Environmental Investigations Alabama Army Ammunition Plant, Childersburg, Alabama

Date	Title/Author	Summary
May 1978	Installation Assessment of ALAAP (USATHAMA)	Initial study; specific areas of the facility were found to be potentially contaminated by explosives and lead.
July 1981	Environmental Survey of ALAAP (ESE)	Identified the type and extent of contamination due to past operations in order to release ALAAP as excess property.
June 1983	Confirmatory Environmental Survey, ALAAP, Final Report (ESE)	Further defined the extent of contamination in the Industrial Area and part of the GSA Area and characterized the hydrogeology of the site.
July 1986	ALAAP RI Final Report (ESE)	The RI yielded findings of nitroaromatic, lead, and asbestos contamination in various media.
September 1987	Preliminary Natural Resource Survey, ALAAP (USFWS)	The survey indicated the presence of critical habitat and endangered species.
November 1987	ALAAP FS, Final Report (ESE)	An FS was performed to develop remedial responses to uncontrolled releases.
January 1991	Stockpile Characterization Report for ALAAP (ESE)	Explosives, lead, and asbestos were identified at concentrations greater than acceptable regulatory limits.
September 1991	RI/FS of the Industrial Sewer System, ALAAP (ESE)	Recommended excavation, onsite mobile rotary kiln incineration, and onsite landfilling for the nitroaromatic contaminated media in the vicinity of the sewerlines and manholes.
October 1991	FS for the ALAAP Soil Stockpile Area (Roy F. Weston)	Incineration identified as the preferred remediation method.
December 1991	ROD, ALAAP, Alabama Stockpile Soils Area Operable Unit (Lt. Colonel T.E. Dresen, Commander, Alabama Army Ammunition Plant)	A ROD was filed for Stockpile Soils in Building TC4A in Area B with incineration as the chosen remediation method.
August 1992	Supplemental RI/FS for Area B, ALAAP, Final Baseline Risk Assessment, Vol. I, II (ESE)	Established the risks to public health, welfare, and the environment.
June 1993	Supplemental RI/FS for Area B, ALAAP, Final Remedial Investigation, Vol. I, II (ESE)	This RI updated the 1986 RI and further characterized Area B by summarizing the data collected during this investigation with data obtained during previous surveys.
April 1994	IROD Stockpile Soils (Roy F. Weston)	Identified stabilization and incineration as the preferred remedial alternatives.
April 1994	CERFA Report (TETC)	Investigation initiated by BRAC and CERFA to identify real property that could immediately be reused and/or redeveloped; identified new study areas.
November 1994	IROD, ALAAP, Study Areas 6, 7, 10, and 21 of the Area B Soil Operable Unit (Roy F. Weston)	The interim remedial action consisted of excavating, transporting, onsite thermal treatment/solidification, and landfilling of 400,000 cubic yards of contaminated soils.

Red Water Storage Basin, the Northern and Southern TNT Manufacturing Areas, the Aniline Sludge Basin (Study Area 9), the Tetryl Manufacturing Area, the Flashing Ground (Study Area 16), the Red Water Ditch, and the Beaver Pond Drainage System (Study Area 27). Nitroaromatic residues were detected in soil and sediment in the TNT manufacturing areas and the Red Water Ditch and were cited as a potential source of groundwater contamination. Groundwater contamination by nitroaromatic compounds was detected in the shallow groundwater beneath the TNT manufacturing areas (ESE 1983).

The initial RI was conducted on ALAAP by ESE using data obtained on the facility between 1980 and 1986 (ESE 1986) to identify and fill data gaps identified from the previous environmental surveys. The study evaluated 15 study areas, including the 8 areas evaluated during the environmental surveys (ESE 1981, 1983) and the Sanitary Landfill and Lead Facility (Study Area 3), the Old Burning Ground, the Old Well, the Lead Facility (Study Area 19), the Demolition Landfill (Study Area 22), the Storage Battery/Demolition Debris Area (Study Area 25), the Crossover Ditch (Study Area 26), and the Flaker Screen Wash Area. The RI concluded that sediments in the major facility drainages (Beaver Pond, Crossover Ditch, and Red Water Ditch) were contaminated with nitroaromatic compounds and surface water concentrations of nitroaromatic compounds were detected in the Beaver Pond Drainage System and the Red Water Ditch. Consistent with the previous environmental surveys, groundwater contamination by nitroaromatic compounds in the TNT manufacturing areas was detected during the initial RI. Soil in the TNT manufacturing areas and the Old Burning Ground contained nitroaromatic residues that were associated with the former manufacturing and subsequent demolition activities on ALAAP. Extractable lead concentrations were detected at the Lead Facility site. Asbestos and friable asbestos were detected during the study over all areas where buildings were razed and scattered during demolition (ESE 1986).

A Supplemental RI was conducted by ESE between 1989 and 1990 to fill identified data gaps associated with the previous site studies. The scope of the Supplemental RI was to further quantify the extent of groundwater contamination, assess ecological and human health exposures, and revise the project FS. The Supplemental RI evaluated seven study areas, including the TNT manufacturing areas, the Flashing Ground, the Red Water Ditch, the Crossover Ditch, the Beaver Pond Drainage System, and the Area A and B Divide. The supplemental study concluded that although groundwater contamination by nitroaromatic compounds was detected in shallow and deep groundwater, significant migration from the sites was not occurring. Nitroaromatic compounds and dissolved lead were not detected during the analysis of groundwater from public supply wells during the Supplemental RI. Nitroaromatic compounds were not detected in surface water or sediment samples from the site drainages (ESE 1993).

A Characterization Study (ESE 1991c) was conducted in 1991 to assess stockpiled soil that was excavated from Area A and stored in Area B. In October 1991, an FS (Weston 1991) was completed for these soils and a ROD was issued in December 1991 (Dresen 1991). The ROD recommended incineration as the preferred alternative. An Interim Record of Decision (IROD) for the Stockpile Soils was approved in April 1994 (Weston 1994a). The IROD identified stabilization

and incineration as the preferred remedial alternatives. The soils were excavated, stabilized, and transported to Backfill Area No. 1 in December 1994.

A CERFA investigation was conducted at ALAAP in April 1994 under the BRAC environmental restoration program, as required by Public Laws 100-526 and 101-510 (TETC 1994). The associated report identified real property in Area B that could be immediately reused and redeveloped. The study also identified six additional areas with environmental concerns that were not considered during previous investigations. These areas include Building 6 – Coke Oven, a transformer storage building, downed utility poles with transformers, a former gas station, UST sites, and a fertilizer and pesticide storage building.

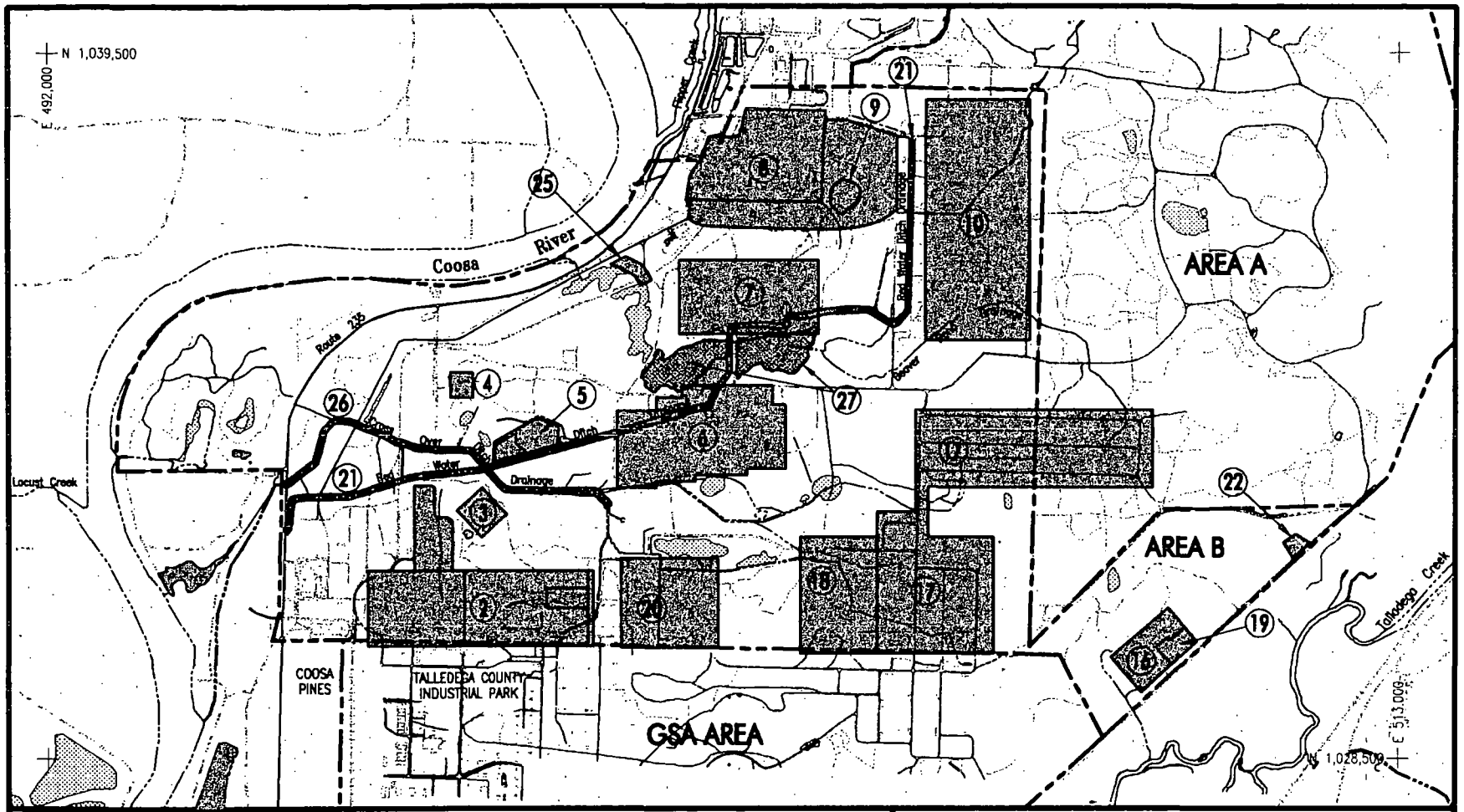
In November 1994, an IROD was approved to remediate soils, sediments, and vitrified clay pipes (VCPs) in Study Areas 6, 7, 10, and 21. Incineration was selected as the primary treatment technology with stabilization as the secondary treatment technology, if required (Weston 1994a).

1.4.4 RI Study Area Descriptions

Physical descriptions of the 19 study areas and 6 CERFA areas investigated under the ALAAP Supplemental RI are summarized below. Two areas, the Stockpile Soils and Industrial Sewerline System (except for Study Area 8), were not investigated under this Supplemental RI because remediation activities previously had been conducted or planned under a separate contract. The principal findings and analytical results from previous investigations also are summarized for each study area. The study area locations are shown in **Figure 1-7**.

Study Area 2 – Smokeless Powder Facility—The majority of the Smokeless Powder Facility was located on 74 acres in the Leaseback Area south of Area B. The 1986 RI Report (ESE 1986) stated that the buildings associated with the Smokeless Powder Facility were decontaminated and burned, the equipment was decontaminated and salvaged, and the area was transferred back to Kimberly-Clark. During the Exploratory Survey (ESE 1981), zinc and mercury were detected above background concentrations in groundwater. 2,4-Dinitrotoluene (2,4-DNT) was detected at 0.15 μg/g in two sediment samples located near the outfalls from the contaminated sewers of the Series 237 Buildings. 2,4-DNT residues also were detected in soil samples at a maximum concentration of 1.4 μg/g within 30 feet of a building foundation.

Study Area 3 – Sanitary Landfill and Lead Facility—The Sanitary Landfill was located in the west-central portion of the current Area B and covered 7.5 acres. The landfill was used from the early 1940s until the late 1970s. According to the Exploratory Survey (ESE 1981), most of the fill material was domestic solid waste and building rubble. During previous investigations (ESE 1981, 1993), nitroaromatics, polychlorinated biphenyls (PCBs), and metals (mercury and lead) were detected in the site soil. One sample contained 1.53 μg/g of 1,3,5-trinitrobenzene (1,3,5-TNB), one sample contained 0.539 μg/g of nitrobenzene (NB), and two samples contained 0.449 and 1.17 μg/g of TNT. Soil samples contained lead in concentrations ranging from 30 to 11,000 μg/g at a depth of



LEGEND:

- AREA BOUNDARIES
- PRIMARY ROADS
- SECONDARY ROADS
- TRAILS
- BUILDINGS
- FENCE
- RAILROAD
- WETLANDS
- CREEK AND TRIBUTARIES
- (10) STUDY AREAS
- GRID BASED ON ALABAMA STATE PLANE EAST

SCALE 1"=2500' FT.

STATE PLANE GRID

NOTES:

1. BASE MAP OF AREA B RECEIVED FROM AIR SURVEY CORP. MAP COMPILED FROM AERIAL SURVEY FEBRUARY 1995.
2. OUTSIDE AREAS OF BASE MAP RECEIVED FROM AMERICAN DIGITAL CARTOGRAPHY SCANED FROM USGS CHILDERSBURG 7.5 QUADRANGLE, 1984, 1" = 100,000'.

U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

Area B
Study Areas

Figure No.	Project No.	File Name	Date
1-7	01-1033-03-8178-045	99015\DWGS\E42BASE	03-31-99

4 inches to 7.5 feet (ESE 1981). Only one sample collected during the RI Survey (ESE 1986) contained leachable lead (15.2 µg/g). However, this was attributed to the difficulty in precisely determining the location of the old lead facility because of vegetation overgrowth. Both friable and Transite asbestos materials were mixed in the landfill soil. Asbestos contamination is estimated to cover 2.5 acres and occupy a volume of 21,580 cubic yards within the landfill. No organic or inorganic contaminants were detected in the groundwater; however, trace concentrations of nitrate were detected. Nitroaromatic residues were not detected in surface drainages downstream from the landfill (ESE 1981).

Study Area 4 – Manhattan Project Area—The Manhattan Project Area used a portion of ALAAP located in the western part of the GSA Area from 1943 to 1945 (DA 1978). The Manhattan Project Area was designed to produce 1,600 pounds (192 gallons) of heavy water per month, but records indicate that it produced less than 600 pounds (72 gallons) per month (DOE 1989). A total of 11,160 pounds (1,338 gallons) of heavy water were produced from January 1944 through July 1945. The heavy water process did not involve any radioactive materials. In 1945 and 1946, all buildings were removed from the Manhattan Project Area except for one small brick building, which was removed in 1995. During the demolition, Transite asbestos was scattered over the area (ESE 1993). Lead was detected in two soil samples collected at 4 inches below land surface (BLS) at 50,000 and 300,000 µg/g. Organic bases or nitroaromatics were not detected in the soil samples. The groundwater analyzed was not contaminated with organics or inorganics (ESE 1981).

Study Area 5 – Red Water Storage Basin—The Red Water Storage Basin was intended to be used as a settling basin for TNT manufacturing process wastewaters. The basin was located on the northern side of the Red Water Ditch, approximately 1,000 feet to the west of the Southern TNT Manufacturing Area. The basin covered approximately 9 acres and was surrounded by a 6-foot high earthen berm. The dike and basin floor were constructed of clay. An entry pipe was located at the southeast corner and an exit flume was located in the southwest corner of the basin. During previous investigations (ESE 1981), 2,4-DNT (10.0 µg/L) and cadmium (15.0 µg/L) were detected in groundwater samples. 2,6-Dinitrotoluene (2,6-DNT) and TNT were possibly present in the groundwater; the concentrations detected were slightly lower than the natural water detection limits of 1.3 and 0.41 µg/L, respectively. Nitroaromatics were not detected in the two wells downgradient from the Red Water Storage Basin (ESE 1983). A low concentration of TNT (0.14 µg/g) was detected in sediments in the immediate area of the waste inlet (ESE 1981).

Study Area 6 – Southern TNT Manufacturing Area—The Southern TNT Manufacturing Area, sometimes referred to as the new TNT area, contained four TNT production lines. All that currently remains of the former structures in this area are the roadways and portions of building foundations.

Soil samples were collected during the Exploratory Survey (ESE 1981) and Confirmatory Survey (ESE 1983). Maximum concentrations of contaminants detected during these two surveys were as follows: 2,4-DNT (0.55 and 16 µg/g), 2,6-DNT (0.8 and 3.3 µg/g), 1,3,5-TNB (1.314 µg/g), and TNT (2.72 and 7,660 µg/g). Samples also were collected at the site from soil that had been

dredged from the Red Water Ditch and deposited on the edge of the study area drainway during 1953-54 renovation activities. Elevated concentrations of TNT (3,000 µg/g), 2,4-DNT (0.793 µg/g), and 2,6-DNT (4.84 µg/g) were detected in these soils (ESE 1981). During the RI Survey (ESE 1986), extractable lead was detected below the detection limit (14 µg/g) at 2 inches BLS.

Nitric acid and nitroaromatics were detected in groundwater samples collected during previous investigations that were likely the result of past production and nitration operations at the study area. Groundwater samples were collected during the Exploratory Survey (ESE 1981), Confirmatory Survey (ESE 1983), RI Survey (ESE 1986), and Supplemental RI (ESE 1993). During the Exploratory Survey (ESE 1981), particles of nitroaromatic residues of up to 40 mm in diameter were found across the surface of the spoil banks and larger pieces were found in the manholes in the industrial sewer system. Nitroaromatics of concern in the samples collected during the Exploratory Survey (ESE 1981) were detected at the following maximum concentrations: NB (36.1 µg/L), 2,4-DNT (4,340 µg/L), 2,6-DNT (860 µg/L), 1,3-dinitrobenzene (1,3-DNB) (466 µg/L), TNT (10,270 µg/L), and 1,3,5-TNB (4,380 µg/L). During the Confirmatory Survey (ESE 1983), the maximum concentrations were as follows: TNT (22,000 µg/L), 2,4-DNT (3,570 µg/L), 2,6-DNT (1,080 µg/L), and 1,3,5-TNB (2,010 µg/L). Maximum concentrations of nitroaromatics detected during the RI Survey (ESE 1986) was as follows: TNT (1,910 µg/L), 2,4-DNT (299 µg/L), 1,3-DNB (305 µg/L), 1,3,5-TNB (215 µg/L), and NB (58.7 µg/L). Maximum concentrations detected in groundwater samples collected from shallow monitoring wells during the Supplemental RI (ESE 1993) were as follows: 1,3,5-TNB (3.77 µg/L) and TNT (27.2 µg/L). Maximum concentrations detected in groundwater samples collected from deep monitoring wells during the Supplemental RI (ESE 1993) were as follows: 1,3-DNB (2.95 µg/L), 2,4-DNT (19.1 µg/L), 2,6-DNT (6.56 µg/L), and 1,3,5-TNB (1.77 µg/L).

Transite-containing rubble from building demolition is located around or near the building foundations. Friable asbestos was found in large pieces along the pipelines associated with the study area buildings (ESE 1981).

Study Area 7 – Northern TNT Manufacturing Area—The Northern TNT Manufacturing Area, also known as the old TNT manufacturing area, contained four TNT production lines and one DNT production line. This former production area has since been razed. Material was spread over a wide area during the demolition; only foundations and portions of the sewer system remain. Formerly, wastewater from this area was dumped into the open Red Water Ditch and into wooden flumes, which carried the production wastes to the industrial sewers. Nitroaromatics were detected in soil and groundwater samples collected during previous investigations (ESE 1981, 1983, 1986).

During the Exploratory Survey (ESE 1981), the following maximum concentrations of nitroaromatics were detected in the soil: 2,4-DNT (4.67 µg/g), 2,6-DNT (0.233 µg/g), 1,3,5-TNB (2.78 µg/g), 1,3-DNB (0.318 µg/g), and TNT (698 µg/g). The following maximum concentrations were detected in soil samples collected during the Confirmatory Survey (ESE 1986): TNT (4,250 µg/g), 2,4-DNT (4.96 µg/g), and 2,6-DNT (15.6 µg/g). Extractable lead was detected in four

of five surface soil samples collected during the RI Survey (ESE 1986) at concentrations ranging from 20.7 to 94.4 µg/g.

Nitroaromatics were detected in groundwater collected during the Exploratory Survey (ESE 1981), Confirmatory Survey (ESE 1983), and RI Survey (ESE 1986). Maximum concentrations detected during the Exploratory Survey (ESE 1981) were as follows: 2,4-DNT (21.0 µg/L), 2,6-DNT (38.7 µg/L), and TNT (74.4 µg/L). TNT also was detected at 140 µg/L in water seeping from a spring immediately south of well P-11. Maximum concentrations (averages of duplicate samples) of TNT (119 µg/L), 2,4-DNT (116 µg/L), and 2,6-DNT (71.1 µg/L) were detected during the Confirmatory Survey (ESE 1983). Maximum concentrations of TNT (249 µg/L), 2,4-DNT (296 µg/L), 2,6-DNT (200 µg/L), 1,3-DNB (0.851 µg/L), and 1,3,5-TNB (51.2 µg/L) were detected in groundwater samples collected during the RI Survey (ESE 1986).

As with the Southern TNT Manufacturing Area, friable asbestos was found along the pipelines associated with the study area buildings (ESE 1981).

Study Area 8 – Acid/Organic Manufacturing Area—The Acid/Organic Manufacturing Area produced nitrobenzene, concentrated nitric acid, oleum, and sodium sulfite (sellite) to form aniline and N-N-dimethylaniline. A former sulfur burning pit also is located in this area (DA 1978). The area currently covers 104 acres. Portions of the area have experienced extensive earthworks that have exposed and mixed both Transite and friable asbestos from the former buildings with the soils (ESE 1993). The area containing the asbestos covers 12 acres. Sulfur residues up to 1 inch in diameter were exposed on the ground surface in the sulfur storage area (ESE 1981). Previous investigations identified an area of 1,615 square feet that is contaminated with sulfur and acid wastes. Nitrobenzene (0.53 µg/g) and lead (600 µg/g) also were detected in soil samples and nitrite/nitrate was detected in groundwater samples (ESE 1981). No leachable lead was detected in the five soil samples collected (ESE 1986). Organics and inorganics were not detected in the groundwater (ESE 1981).

Study Area 9 – Aniline Sludge Basin—The Aniline Sludge Basin covers approximately 5 acres and was used to store liquid wastes and sludges from the production of aniline and oleum in the Acid/Organic Manufacturing Area (DA 1978). Wash water from acid tanks was collected in the basin between 1967 and 1968. The unlined basin was designed to collect spillage and some wastewater from the southwest portion of the plant and ash from the northern power plant also may have been disposed of in the basin. Neutralizing chemicals were used in the pond to equalize the pH. An industrial outfall is located on the western side of the basin. Although the pond contains water year-round, it becomes shallow during the dry season, usually the summer months. No contamination was detected in surface water collected during the Exploratory Survey (ESE 1981). 2,4-DNT was detected at 2.1 µg/L during groundwater monitoring; however, groundwater contamination was not detected during confirmatory sampling (ESE 1983). TNT (0.258 µg/g), 1,3-DNB (0.300 µg/g), and 1,3,5-TNB (1.97 µg/g) were detected in a sediment sample collected where the wastes entered the lagoon. Cadmium, nickel, chromium, copper, and zinc were detected in two sediment samples collected during previous investigations (ESE 1981).

Study Area 10 – Tetryl Manufacturing Area—The Tetryl Manufacturing Area consisted of 12 manufacturing lines where tetryl was produced in a two-step process by first sulfonating N,N-dimethylaniline and then nitrating the resulting intermediate. Extensive amounts of lead were used in the piping, floors, and fittings of the nitration houses (ESE 1981). The buildings have been razed and all that remains of each line are the concrete building foundations. Earthworks have scattered both friable and Transite asbestos associated with the buildings over the study area. The current investigation area covers 98 acres. During the Installation Assessment (DA 1978), explosives material was recovered from the soil surface (DA 1978). Lead (30 to 2,000 µg/g) and tetryl (0.708 to 13,600 µg/g) were detected in soil from the Tetryl Manufacturing Area during the Exploratory Survey (ESE 1981). Leachable lead was detected in two of five soil samples collected during the RI Survey at 24.3 and 2,338 µg/g (ESE 1986). Diphenylamine (82.5 µg/L) and tetryl (8.2 µg/L) was detected in the groundwater samples collected during the Exploratory Survey (ESE 1981). Nitroaromatics, including tetryl (maximum concentration of 38.4 µg/L), was detected in a well installed during the Confirmatory Survey (ESE 1983). A sample collected from this same well during the RI Survey (ESE 1986) also contained tetryl (72.8 µg/L). No contamination was observed in the groundwater samples collected from the other wells during the Confirmatory Survey (ESE 1983).

Study Area 16 – Flashing Ground—The Flashing Ground covers 16.5 acres and consists of trenches that were used after World War II to burn combustible trash and explosives materials. Previous soil sample results (ESE 1981) identified lead up to a depth of 3 feet (maximum concentration of 1,900 µg/g), TNT (< 37 to 2,350 µg/g), 2,6-DNT (< 102 to 757 µg/g), 2,4-DNT (< 112 to 1,870 µg/g), 1,3,5-TNB (< 386 to 3,920 µg/g), and tetryl (< 0.257 to 6.62 µg/g). 2,4-DNT was detected in samples (ESE 1993) collected from one existing deep monitoring well (0.885 µg/L) and one new deep monitoring well (1.07 µg/L). 2,4-DNT was detected at 3.6 µg/L in the sample collected from the existing well during the Exploratory Survey (ESE 1981). TNT was detected at 0.085 µg/L in a sample from this same well during the initial RI (ESE 1986), which was below the detection limit for the Supplemental RI (ESE 1993). Total lead was detected in all groundwater samples at concentrations ranging from 4.0 to 32.2 µg/L. Dissolved lead, detected in 8 of 10 monitoring wells sampled, ranged in concentration from less than 1.3 to 12 µg/L. No contamination was detected in the surface water or sediments (ESE 1981).

Study Area 17 – Propellant Shipping Area—A records search conducted as part of the Installation Assessment (DA 1978) identified an old farm well that was constructed before the U.S. Army acquired the land in the area of the Propellant Shipping Area. It was reported that the well was used to dispose of inert material. The Exploratory Survey (ESE 1981) identified this area as the Propellant Shipping Area. Forty-eight shipping houses located in this area were used to store smokeless propellant prior to shipment. Thirteen of the 48 shipping buildings are located on land that previously was sold as part of Area A (ESE 1981).

Thirty-five buildings remaining in Study Area 17 were spot tested for the presence of NC and nitroaromatic residues; 84 percent of the spot tests were positive for NC. One sample contained 139 µg/g of NC. One test indicated the presence of nitroaromatic compounds (ESE 1981).

Contamination may have resulted from debris swept from the floor of the buildings onto the ground surface and from spills and breaks during the storage and shipping process. All buildings were covered with Transite shingles, but no friable asbestos was found (ESE 1981). Of the 24 soil samples collected, one sample contained low concentrations of NC and one sample contained 2,4-DNT (0.37 µg/g) (ESE 1981). The current study area covers 126 acres.

Study Area 18 – Blending Tower Area—The Blending Tower Area was the area where smokeless powder was mixed to make it more homogeneous. During the blending operation, the powder was pneumatically moved to an upper bin and then dropped over an umbrella into a lower bin. This procedure was repeated twice (DA 1978). Historical site drawings indicate that the Blending Tower Area may have been south of the present installation boundary in the southern portion of Area B. The current Study Area 18 is believed to be part of the Propellant Shipping Area for the smokeless powder and has not been investigated prior to the present investigation. One soil sample collected during the Exploratory Survey (ESE 1981) contained 56 µg/g of NC (barely above the detection limit in soil); however, no nitroaromatics or organic base residues were detected. Transite asbestos was located around the foundations of the destroyed buildings (ESE 1981).

Study Area 19 – Lead Facility—The Lead Facility was used during the ALAAP production years for pouring lead ingots (DA 1978). At the time of the Exploratory Survey (ESE 1981), numerous large pieces of lead, some weighing several pounds, were identified on the soil surface in this area. Boulders containing lead cobbles were observed on the ground surface during SAIC's RI field reconnaissance. Sparse and stressed vegetation also was observed. Elevated concentrations of lead (up to 8,700 µg/g) were detected in soil samples collected during the Exploratory Survey (ESE 1981) at 4 inches BLS from the soil surface. A maximum lead concentration of 15,000 µg/g was detected in a slag pile outside the fence at 4 inches BLS from the soil surface. Leachable lead concentrations ranged from 15.9 to 7,692 µg/g (depths ranging from 0.4 inches to 4.5 feet) and was detected in all soil samples collected (ESE 1986). 2,4-DNT was detected in one monitoring well at 3.6 µg/L (ESE 1981) and TNT was detected at 0.092 µg/L (ESE 1986). No contaminants were detected in surface water or sediments (ESE 1993). The current study area covers 2.6 acres.

Study Area 20 – Rifle Powder Finishing Area—Limited information is available on the history of the Rifle Powder Finishing Area. The Exploratory Survey (ESE 1981) activities conducted at the study area included a visual asbestos survey and limited soil sampling. Elevated concentrations of 2,4-DNT (0.639 to 6.095 µg/g) and mercury (1 µg/g) were detected in soil samples analyzed during the Exploratory Survey (ESE 1981). During the asbestos survey, Transite asbestos was found around all building foundations and scattered throughout the area. Friable asbestos was found along all former steamline routes. Asbestos-containing material was identified covering an estimated area of 29.6 acres. The current study area covers 42 acres (ESE 1981).

Study Area 21 – Red Water Ditch—The Red Water Ditch carried the industrial process wastewaters produced by the manufacture of TNT and collected industrial process wastes and surface runoff from the Acid/Organic Manufacturing Area and the Tetryl Manufacturing Area (DA 1978). As initially constructed, the ditch extended from the western side of the Tetryl

Manufacturing Area through the Northern and Southern TNT Manufacturing Areas. Industrial wastes generated in the Acid Organic Manufacturing Area were discharged into the ditch immediately east of the Northern TNT Manufacturing Area (near the former Building 806C). The areas that drained to the Red Water Ditch were involved in the production of acids (sulfuric and nitric), organics (DPA, aniline, and N,N-dimethylaniline), and explosives and their process byproducts (TNT, DNT, and tetryl). Other organics and inorganics (benzene, toluene, sodium, sulfite, sodium carbonate, and elemental sulfur) also were stored in these areas that fed the Red Water Ditch.

The Red Water Ditch was constructed with steep sides and varies from approximately 3 to 10 feet in depth. The ditch crosses other drainage systems through clay pipelines. The ditch contains flowing water only during seasonal wet periods. During dry periods, usually the summer months, the ditch contains water in varied locations. The ditch was cleaned at least once since its original construction. Sediments dredged from the ditch during the cleaning operations were deposited along the banks of the ditch. The Red Water Ditch drainage system carries 17 percent of the surface water at ALAAP, ultimately discharging into the Coosa River (ESE 1981).

The Exploratory Survey (ESE 1981) concluded that surface waters in the Red Water Ditch were contaminated with nitroaromatic compounds at points where the ditch traverses the Southern and Northern TNT Manufacturing Areas. 2,4-DNT was detected at concentrations ranging from 3 to 3.7 µg/L. In addition, lead was detected during the Exploratory Survey (ESE 1981) at two sampling locations (50 and 52 µg/L). Water in the middle section of the Red Water Ditch was contaminated with low concentrations (all below 15 µg/L) of 2,4-DNT, 2,6-DNT, and TNT. DPA was detected immediately downstream from the main Acid/Organic Manufacturing Area discharge point. Asbestos fibers also were found in the surface water. TNT was detected in all soil samples collected during the RI along the spoil banks, with concentrations ranging from 0.665 to 22,000 µg/g. Individual pieces of TNT also were found in the spoil banks. The soil samples collected from the spoil banks during the RI Survey (ESE 1986) also contained 2,4-DNT (0.667 µg/g was detected in one sample), 1,3-DNB (0.221 and 7.70 µg/g), and 2,6-DNT (0.15 and 5.87 µg/g). Leachable lead also was detected at concentrations of 64.4 and 2,733 µg/g. TNT (17.6 µg/g), 2,4-DNT (5.7 µg/g), 2,6-DNT (1.85 µg/g), NB (50.9 µg/g), tetryl (1.2 µg/g), and lead (223 µg/g) were detected in sediment samples collected from the Red Water Ditch (ESE 1981). Above the point where the Red Water Ditch crosses the Crossover Ditch, maximum concentrations of the following chemicals were detected in the sediments: TNT (17.6 µg/g), 2,4-DNT (5.7 µg/g), tetryl (1.2 µg/g), and lead (223 µg/g). Nitroaromatics or organic compounds were not detected below the crossing point (ESE 1981). TNT was detected at 0.880 µg/g at the point where the Red Water Ditch leaves the installation; TNT also was detected at a concentration of 0.184 µg/L where the Red Water Ditch leaves the Southern TNT Manufacturing Area (ESE 1986). Lead and explosives in the sediments were remediated from portions of the Red Water Ditch in 1995 (Weston 1995b).

The Supplemental RI results (ESE 1993) indicated that no nitroaromatic compounds or tetryl were detected in the surface water or sediments.

Study Area 22 – Demolition Landfill—The Demolition Landfill, located near the Flashing Ground, consists of a semicircular landfill in a swale extending approximately 500 feet along Patrol Road. Rubble from demolition activities was dumped in a 50-foot-wide semicircle around the edge of the swale to an average depth of approximately 7 feet. Several hundred pounds of lead in the form of sheets, wire, and pipe were found during the Exploratory Survey (ESE 1981) on the surface at this site. Large amounts of cast iron, stainless steel fittings, aluminum, Transite, and other rubble were found partially buried by concrete and earth. Friable asbestos also was distributed in the soil of this area. In samples collected during the Exploratory Survey (ESE 1981), lead and tetryl were detected (> 354 and 0.6 μg/g, respectively) in the first sample; in the second sample, lead and tetryl (2,160 and 0.55 μg/g, respectively), and polynuclear aromatic compounds (PNAs) were detected. Leachable lead concentrations in the surface soil ranged from 77.9 to 1,538 μg/g (ESE 1986). The current study area consists of 1.8 acres.

Study Area 25 – Storage Battery/Demolition Debris—Study Area 25 was identified during the June 1985 site visit conducted as part of the RI (ESE 1986). Inspection of the disposal site indicated the presence of rubble and at least 20 heavy-duty lead-acid battery casings. The casings consisted of approximately 30 pounds of lead components in a glass casing. Along with the batteries, three mercury switches, each containing 3 to 4 milliliters of liquefied mercury metal, were observed. No mercury was detected in the nine soil samples collected during the RI Survey (ESE 1986); however, lead was detected in the surface samples at a maximum concentration of 118 μg/g. Nitroaromatic compounds, tetryl, or priority pollutants were not detected in the soil (ESE 1986). Low concentrations of lead (15.0 μg/L), zinc (27.4 μg/L), and thallium (57.1 μg/L) were detected in one groundwater sample. The disposal site covers 2.4 acres located in a steep, overgrown ditch that periodically is flooded by water from the Coosa River.

Study Area 26 – Crossover Ditch—The Crossover Ditch drains surface waters from the Leaseback Area, the Rifle Powder Finishing Area, part of the northern and all of the southern portions of the Propellant Shipping Area, the southern portion of the Southern TNT Manufacturing Area, and the Sanitary Landfill and Lead Facility. Two beaver dams have been constructed on the Crossover Ditch—a small dam immediately east of the Series 223 Buildings and a larger dam south of the Southern TNT Manufacturing Area.

Although the Crossover Ditch drains areas that produced NC and smokeless powder, the ditch also passes adjacent to other study areas on ALAAP and contaminants from other sources may enter the drainage. Other identified potential sources of contaminants included the coal pile at the Kimberly-Clark power plant, the Sanitary Landfill and Lead Facility, the pipe flashing area immediately east of Study Area 3, and the large industrial waste reservoir on Kimberly-Clark land directly south of the Rifle Powder Finishing Area (ESE 1981). The Crossover Ditch is estimated to collect and discharge approximately 25 percent of the surface waters generated on or adjacent to ALAAP property into the Coosa River (ESE 1981).

During the Exploratory Survey (ESE 1981), lead, cadmium, copper, and zinc were detected in surface water samples collected from the Crossover Ditch. The upper reaches of the Crossover

Ditch, which flow through the Smokeless Powder Facility, contained an iron oxide film on the water surface and iron staining of the sediments and aquatic vegetation due to the impact of the coal pile. Explosives-related contaminants were not detected. Asbestos fibers were found in the surface water. Nitroaromatic compounds or tetryl were not detected in the surface water samples collected during the Supplemental RI (ESE 1993). Analysis of sediment samples showed residues from coal pile runoff in the upper reaches and evidence of coal pile particulate runoff throughout. Sediments collected during the Exploratory Survey (ESE 1981) downstream from the Smokeless Powder Manufacturing Area and Rifle Powder Finishing Area contained 2,4-DNT (0.14 to 2.5 µg/g) and 2,6-DNT (0.179 to 0.372 µg/g). Although the concentrations of contaminants decreased downstream, 0.992 µg/g of 2,4-DNT was detected in sediments where the Crossover Ditch leaves the installation (ESE 1986). Based upon previous studies, the nitroaromatic and organic based residues appeared to be immobilized in the sediments (ESE 1993).

Study Area 27 – Beaver Pond Drainage System—The Beaver Pond Drainage System flows west between the Southern and Northern TNT Manufacturing Areas and derives its name from two large beaver ponds that affected the original drainage system. The drainage originates in undeveloped areas south and east of the Tetryl Manufacturing Area. Potentially contaminated surface runoff in the Beaver Pond Drainage System originates from the southern end of the Tetryl Manufacturing Area and the shipping houses in the Propellant Shipping Area. Some surface drainage from the Acid/Organic Manufacturing Area, the Tetryl Manufacturing Area, and the Northern TNT Manufacturing Area enters the Beaver Pond Drainage System (ESE 1981).

Surface water sampling conducted during the Exploratory Survey (ESE 1981) indicated potential contamination at one location in the drainage system—the groundwater seepage in the Northern TNT Manufacturing Area, where TNT was detected in the sample. TNT was only detected in the spring at 140 µg/L (ESE 1981). 2,4-DNT and NB were detected in a sediment sample in the Northern TNT Manufacturing Area at 0.71 and 0.56 µg/g, respectively (ESE 1981). 1,3,5-TNB was detected at 0.68 µg/g in a sediment sample collected near the installation (ESE 1981). Nitroaromatic compounds or tetryl were not detected in the surface water or sediments collected from the Beaver Pond Drainage System or the Coosa River at the confluence with the Beaver Pond Drainage System (ESE 1993). Asbestos fibers also were found in samples collected in the drainage system (ESE 1981).

Stockpile Soils—Structures TC4A and TC4B contained contaminated soil that was excavated between 1986 and 1987 from Area A and stockpiled in Area B pending incineration. These soils are referred to as the Stockpile Soils. TC4A was a building, and TC4B is a membrane-covered concrete storage pad. In February 1990, a tornado demolished Building TC4A. Soils from the demolished building were added to structure TC4B and secured with a membrane liner. In February 1991, an FS conducted for the Stockpile Soils area concluded that explosives, lead, and asbestos contamination were present above regulatory limits. The selected remedy for the Stockpile Soils area was to thermally treat and dispose of the soil onsite

(ESE 1987). Since incineration of these soils has occurred, investigation of this area was not conducted as part of the current study.

Industrial Sewerline System—The Industrial Sewerline System (ISS) for the entire ALAAP facility was investigated during the Exploratory Survey (ESE 1981). In Area B, the industrial sewerlines totaled approximately 32,500 feet in length, of which approximately 31,000 feet remain buried. The RI (ESE 1986) defined the nature and extent of contamination within the ISS in the four former production areas: the Southern TNT Manufacturing Area, Northern TNT Manufacturing Area, Acid/Organic Manufacturing Area, and Tetryl Manufacturing Area. Soil, water, and sediment samples collected during the RI from within the surface drainage areas of the ISS identified varying concentrations of nitroaromatic compounds. Roy F. Weston, Inc. was contracted to excavate and remove the system from the site at Study Areas 6, 7, and 10; therefore, no investigation was conducted at the Study Area 6, 7, and 10 portions of the ISS as part of the Supplemental RI.

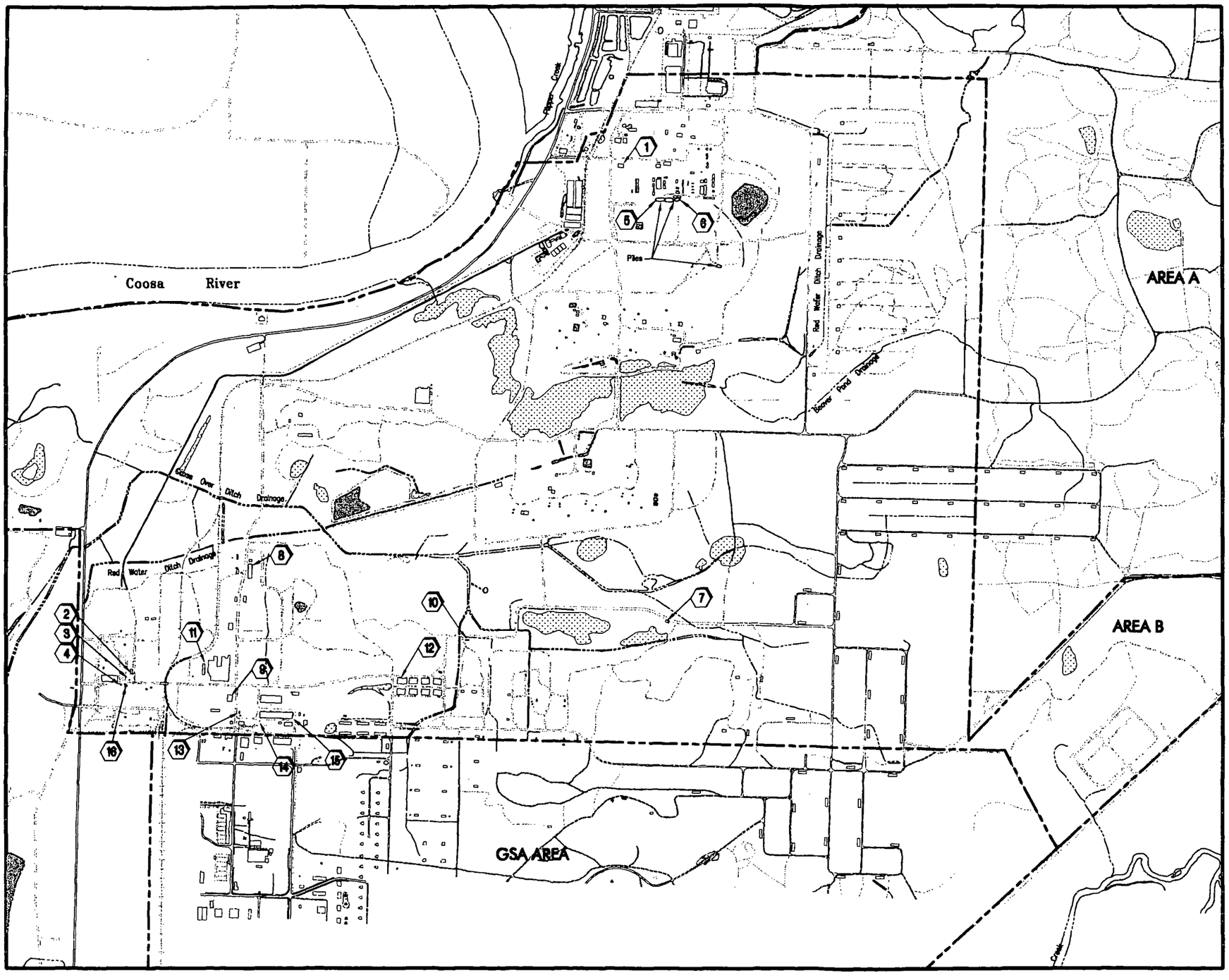
1.4.5 CERFA Study Area Descriptions

A CERFA investigation was conducted by Earth Technology Corporation in 1994. The CERFA investigation identified previously uninvestigated areas on ALAAP that required additional investigation. The following paragraphs summarize the status and history of the CERFA sites that were investigated as part of the current Supplemental RI/FS. The CERFA sites are shown in **Figure 1-8**.

Building 6 – Coke Oven—A concrete-covered pit of unknown dimensions was located next to Building 6 – Coke Oven. The CERFA report identified the pit as a former burning pad where transformer oil was poured onto copper wire to burn off the insulation covering the wire (TETC 1994). It is unknown whether the transformer oil contained PCBs. The concrete pad is still present; however, the pit is not visible.

Transformer Storage Buildings—The CERFA report stated that transformers likely had been stored at one time behind Building 2240 (an instrument shop). Evidence of stressed vegetation that would indicate a release was not noted during the visual inspection of the area. The CERFA report also stated that a leaking transformer was stored in Building 2180, part of the Manhattan Project Area, and was removed in 1987. When demolition activities began in Area A in 1973-74, the contractor stored transformers removed from Area A in Building 2180. When the transformers were removed, contractor cleanup activities consisted of throwing absorbent on any liquids present. In addition, old transformers that were stored behind Building 708A (a cafeteria) have been vandalized (TETC 1994).

Downed Utility Poles with Transformers—During the CERFA visual inspection, a downed utility pole was noted that had blackened soil and an area of bare vegetation around the broken transformer (TETC 1994). Numerous former transformer sites within Area B were identified



LEGEND:

- BUILDINGS
- PRIMARY ROADS
- SECONDARY ROADS
- TRAILS
- FENCE
- AREA BOUNDARIES
- RAIL ROAD
- CREEK, TRIBUTARIES AND RIVER
- WETLANDS
- PONDS, IMPOUNDMENTS
- GRID BASED ON ALABAMA STATE PLANE EAST
- 1 — UTILITY POLES – BUILDING 714B AND 745; BUILDING 302B – UST
- 2 3 4 — UTILITY POLES – BUILDING 703A; 703E; AND 798A
- 5 — STOCKPILE SOILS TC4A
- 6 — STOCKPILE SOILS TC4B
- 7 — BUILDING 724E – GAS STATION
- 8 — BUILDING 6 – COKE OVEN
- 9 — UTILITY POLES – BUILDING 2170
- 10 — BUILDING 223B – PESTICIDES/FERTILIZERS
- 11 — UTILITY POLES – BUILDING 2240 AND TRANSFORMER STORAGE
- 12 — UTILITY POLES – BUILDING 227D
- 13 — UTILITY POLES – BUILDING 704Y
- 14 — UTILITY POLES – BUILDING 715C AND UST
- 15 — UTILITY POLES – BUILDING 717A
- 16 — BUILDING 7200 UST

NOTES:

1. BASE MAP OF AREA B RECEIVED FROM AIR SURVEY CORP. MAP COMPILED FROM AERIAL SURVEY FEBRUARY 1995.
2. OUTSIDE AREAS OF BASE MAP RECEIVED FROM AMERICAN DIGITAL CARTOGRAPHY, SCANED FROM USGS CHILDERSBURG 7.5 QUADRANGLE, 1984, 1" = 100,000'.

0 700 1400 2800

SCALE: 1" = 1400'

STATE PLANE GRID

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CHILDERSBURG, ALABAMA

CERFA
Site Location Map

Figure No.	Project No.	File Name	Date
1-8	01-0827-03-8178-045	99015\DWGS\E42CERF	03-31-99

during the CERFA investigation. None of the transformers had been tested for PCB contamination. Twenty-seven poles were identified. Locations of the 27 utility poles were assigned a number that corresponds to the closest building. A list of the downed poles is provided below:

- 708A—Three utility poles on the north side
- 703E—Two utility poles on the northwest portion
- 703A—Two utility poles on the southwest and one on the southeast portion
- 2240—Eight utility poles on the south side
- 2170—One utility pole on the southeast and two on the south side
- 704Y—Three utility poles on the north side
- 717A—Two utility poles on the northeast and one on the southwest portion
- 715C—One utility pole on the southeast portion
- 227D—One utility pole on the north side.

Underground Storage Tanks—The CERFA report identified two 12,000-gallon USTs that were removed in 1993: one UST was located near Building 302B (Ammonia/Oxidation Plant) and one near Building 715C (a flammable materials storehouse). One of the USTs contained gasoline and the other contained diesel fuel; it is uncertain which UST contained diesel or gasoline (TETC 1994). During the current field investigation, a third potential UST site was observed at the southern end of Area B in the vicinity of Building 720D.

Fertilizer and Pesticide Storage Building—The CERFA report identified Building 223B as an area that was used to store fertilizers and pesticides. It was leased approximately 20 years ago from the U.S. Army by the Parker Fertilizer Company in Sylacauga, Alabama for pesticide storage. By 1991, the contents of the building were removed prior to initiation of demolition activities at ALAAP. No releases associated with this building have been reported (TETC 1994).

Gas Station—The CERFA report (TETC 1994) identified a potential gas station located in Area B. Building 724E was reported by an Inventory of Military Real Property as a gas station without a building (i.e., pump stations). The only information available on the gas station stated that the USTs associated with the stations were installed in 1942. All USTs reportedly have been removed.

1.4.6 Site Remediation Activities

As a result of the 1994 IROD, Roy F. Weston operated a treatment system at ALAAP for solids that were contaminated with hazardous materials at Study Areas 6, 7, 10, and 21. The system included a transportable incineration system (TIS) to treat explosives-contaminated solids and a stabilization process to treat solids contaminated with metals. Area B soils and sediments from Study Areas 6, 7, 10, and 21 were treated as a result of the 1994 IROD (Weston 1994a).

The locations of contaminated soil removed from Study Area 6 included soil surrounding the tri-nitration house, the wash house, and the pipelines and open ditches associated with the sewer system leading to the Red Water Ditch. A total volume of 27,703 cubic yards of contaminated soil (>100 parts per million [ppm] explosives) were removed from Study Area 6 (Weston 1996a). Contaminated soils were removed from Study Area 7 (17,120 cubic yards; >100 ppm explosives) in manufacturing and production areas similar to Study Area 6; however, soil also was removed near the recovery house and mono-nitration house along one line (Weston 1996a). Sediment was removed in Study Area 21 (16,083 cubic yards; >100 ppm explosives) primarily from outfall areas associated with Study Areas 6 and 7 (Weston 1996a). Study Area 21 required a considerable amount of sediment removal due to the extent of contamination. Soil was removed from the tetryl lines formerly located in Study Area 10 (13,034 cubic yards; >2,000 ppm explosives) (Weston 1996a). Specific locations of soil removal included the refining and nitrating houses and the open ditches leading to the Red Water Ditch (USACE 1999).

As of February 1999, approximately 68,627 cubic yards of explosives-contaminated soil and sediment were excavated from Study Areas 6, 7, 10, and 21 and incinerated (USACE 1999). In addition, at Study Areas 6, 7, and 10, approximately 14,000 linear feet of encased contaminated industrial sewer system was deactivated and decontaminated (Weston 1996d). Approximately 5,800 linear feet of un-encased contaminated industrial sewer system was deactivated, excavated, and decontaminated or incinerated (Weston 1996d).

As a result of SAIC's Supplemental RI, additional areas of contaminated soil were identified and remediated in several study areas (SAIC 1996a). Other remedial actions were conducted as a result of recommendations presented in the Draft Final RI Report (SAIC 1996a). These remedial actions are discussed below.

In 1996, Roy F. Weston prepared an IROD for the remediation of soils at Study Areas 2, 10, 16, 17, 19, and 22 (Weston 1996c). This IROD was prepared so that contaminated soils could be remediated at the time when Roy F. Weston was operating the TIS and stabilization system. Several small areas (i.e., "hotspots") of explosives-contaminated soils were identified by SAIC within Study Areas 2 and 17 (SAIC 1996a). The soils were located, excavated, and incinerated by Roy F. Weston in the TIS system.

Explosives (primarily TNT and 2,4-DNT) and lead contaminated soils at Study Areas 16 and 19 were identified during the Supplemental RI (SAIC 1996a) and included for remediation in the 1996 IROD (Weston 1996b, 1996c). The soils were present in areas that were used for burning and flashing combustible trash and explosives materials (Study Area 16) and for pouring lead ingots (Study Area 19). All soils that contained explosives and lead above the applicable criteria were divided into grids, excavated, transported, and incinerated by Roy F. Weston in the TIS system. The criteria used for excavation of soils are provided in **Table 1-3** (Weston 1996c). Tested incinerator ash with high lead concentrations was stockpiled for future solidification and stabilization. Soil from grids containing only lead contamination was temporarily left in place. All

excavated areas were backfilled with uncontaminated borrow soils and graded to pre-excavation contours.

Table 1-3. Excavation Cleanup Goals
Alabama Army Ammunition Plant, Childersburg, Alabama

Compound/ Analyte Class	Compound/Analyte	Criteria
Explosives	1,3-DNB	> 1 ppm
	2,4-DNT	>356 ppm
	2,6-DNT	>356 ppm
	Tetryl	>5,000 ppm
	1,3,5-TNB	>36.7 ppm
	TNT	>348
Metals (total)	Lead	>400 ppm

Source: Roy F. Weston 1996c

A total of 14,444 cubic yards of TNT-contaminated soils were excavated from Study Areas 2, 16, 17, and 19 and incinerated in the TIS system operated by Roy F. Weston. This work is complete and a draft closure report is pending (USACE 1999).

Subsequent to the Roy F. Weston effort, Environmental Chemical Corporation (ECC) performed additional remediation of soils at Study Areas 16 and 19. The remaining lead-contaminated soils were excavated and treated by stabilization using an onsite pugmill. ECC used an excavation criteria for lead of 300 ppm. Any remaining stockpiled incinerator ash with high lead concentrations also was treated in the onsite pugmill. A total of 1,500 cubic yards of lead-contaminated soils were excavated by ECC and stabilized using the pugmill treatment unit (USACE 1999). The Closure Report for Study Areas 16 and 19 is pending. Incinerator ash and stabilized soils from Area B were disposed of in landfill cells located within Study Area 8. Cells 1 through 8 are completed. Closure Reports are pending (USACE 1999).

Study Area 22 also was identified as an area that required remedial action in the Draft Final RI Report (SAIC 1996a). The Draft Final Feasibility Study (SAIC 1996b) recommended capping of this landfill to prevent future disturbance of the buried material or infiltration. The landfill was capped and work is completed. The Closure Report is pending (USACE 1999).

The tar-like substance at Study Area 9 and the sediments beneath the tar identified during the Supplemental RI (SAIC 1996a) also have been remediated. A Draft IROD was prepared that addressed the tar-like material at Study Area 9 (Weston 1996b). Excavation cleanup criteria for organic compounds and metals were presented in the Draft IROD. In February 1999, ECC excavated the tar and contaminated sediments from the Aniline Sludge Basin (ECC 1999). A total of 3,063 cubic yards of material was excavated and landfilled. The excavated area was backfilled, compacted, and seeded. The Closure Report is pending (USACE 1999).

Following completion of the Phase 1 Supplemental RI, a recommendation was made to remediate PCB-contaminated soils present near several downed utility poles with transformers. Excavation and disposal of the soils was conducted and a Closure Report is pending (USACE 1999).

2. ENVIRONMENTAL SETTING

Information regarding the physical characteristics of the environment in the vicinity of the Alabama Army Ammunition Plant (ALAAP) is provided in this section. The information used to characterize the physical setting includes demographics and land use, physiography, topography, climate, geology, hydrogeology, hydrology, vegetation, and wildlife.

2.1 DEMOGRAPHICS AND LAND USE

ALAAP is located in northeastern Alabama, in Talladega County, approximately 40 miles east-southeast of Birmingham and 70 miles north of Montgomery, Alabama. The town of Childersburg is located 4 miles south of the site. ALAAP was established in 1941 on 13,233 acres of land near the junction of the Coosa River and Talladega Creek. The area included in the present study (Area B) consists of 2,187 acres adjacent to the Coosa River. ALAAP is bounded by Little Blue Creek to the north, the Coosa River to the west, and Talladega Creek and a pulp mill to the south. Property formerly owned by the U.S. Army (Area A), and presently established as a game preserve, bounds Area B to the east.

The majority of Area B was cleared when the original facility was constructed. A woodland management plan was instituted after cessation of operations that allowed for the planting of 3,411 acres of controlled pine forest. Logging operations have continued since the facility was closed in 1973 and numerous logging roads are present onsite (ESE 1981). The facility is presently in controlled access, caretaker status with numerous interior paved roads, warehouses, railroads, bridges, and processing and storage facilities that are in various states of demolition and/or disrepair. The site area is heavily vegetated and many of the remaining plant facilities are overgrown and obscured by the vegetation.

There is no resident population on Area B of the facility and all military operations at ALAAP have ceased. The population in Talladega County as of the 1990 census was 74,107 (CCC 1990). The population has remained fairly constant since 1960. The population decreased by 1 percent from 1960 to 1970 and increased by 5 percent from 1970 to 1980. From 1980 to 1990, population growth decreased by 10 percent (to a population of 74,107) (ESE 1996). The population in the city of Childersburg as of the 1990 census was 4,780 (CCC 1990). The population within a 10-, 20-, and 30-mile radius of Childersburg as of the 1990 census was 32,970, 89,604, and 440,279, respectively (CCC 1995).

According to the Talladega Chamber of Commerce, no plans for developing the ALAAP site have been made. A total of 128 acres of land north of ALAAP have been converted into an industrial park. The south end of State Road 280 and the area along U.S. Highway 231/280 have been developed industrially (ESE 1996). A pulp mill, owned and operated by Alliance Forest Products, Inc. (previously Kimberly-Clark Corporation), borders Area B of ALAAP to the south and is the largest employer in the area (CCC 1990). This is the closest industrial activity to the site.

Other major employers in Childersburg include the Avondale textile mills, White Knight Hospital Disposables, and Prince Island Apparel (IDBC 1997). No zoning restrictions are found in the ALAAP area.

2.2 PHYSIOGRAPHY AND TOPOGRAPHY

ALAAP lies within the Coosa Valley district of the Valley and Ridge physiographic province in Alabama. The physiographic provinces of Alabama are shown in **Figure 2-1**. The border between the Valley and Ridge province and the Piedmont province occurs approximately 100 miles south of the facility.

An aerial survey and topographic mapping were conducted for Area B as part of the current Remedial Investigation (RI). The topographic map generated from the aerial survey is shown in **Figure 2-2**. The ground surface elevation at ALAAP ranges from approximately 410 feet above mean sea level (msl) near the Coosa River to more than 500 feet msl in the eastern portion of Area A (USGS 1958 and 1972). The majority of Area B is located in the 100-year floodplain of the Coosa River. Surface topography over the former production areas on Area B is relatively flat with topographic relief of 20 feet between the Coosa River to the west and the Tetryl Manufacturing Area (Study Area 10), Propellant Shipping Area (Study Area 17), and Blending Tower Area (Study Area 18) to the east. Surface topography east of Study Areas 10, 17, and 18 ranges from elevation 430 feet msl to elevation 520 feet msl with topographic relief of 90 feet. The Flashing Ground (Study Area 16), Lead Facility (Study Area 19), and Demolition Landfill (Study Area 22) and portions of Study Areas 10, 17, and 18 are located in this area of higher relief. The original site topography was modified to accommodate farming activities prior to the ALAAP facility construction in 1941 and was altered substantially during site construction and plant operation.

ALAAP is drained by several naturally occurring, westward-flowing streams that lie outside the current site boundaries (i.e., Talladega and Little Blue Creeks) and by two manmade drainage ditches (Crossover Ditch [Study Area 26] and Red Water Ditch [Study Area 21]). Standing water bodies were not present on the facility during ALAAP's active operation period; however, since the plant demolition activities in 1973, damming activities by the beaver population have resulted in the creation of two major beaver ponds. Several marshy areas also have been created as a result of the ponding water. The majority of the surface runoff from Area B drains to the west/southwest into the Coosa River. The primary streams and their associated drainages and the estimated percentage of Area B that they drain include: Talladega Creek, 18 percent; Little Blue Creek, 12 percent; Red Water Ditch, 17 percent; Crossover Ditch, 25 percent; and Beaver Pond Drainage System, 25 percent (SAIC 1995a).

2.3 CLIMATE AND METEOROLOGY

The town of Childersburg is located in north-central Alabama in the foothills of the Appalachian mountains, approximately 300 miles inland northeast from the Gulf of Mexico.

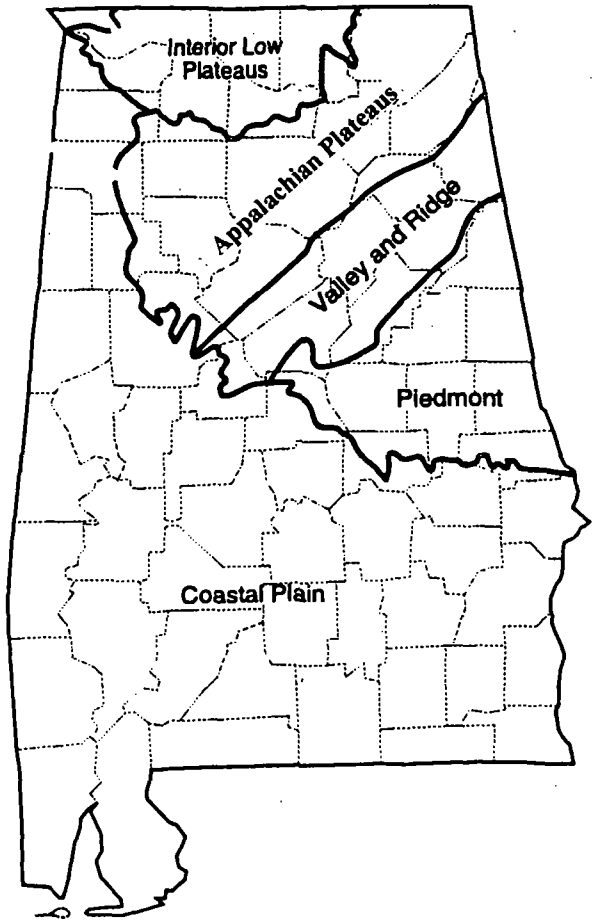
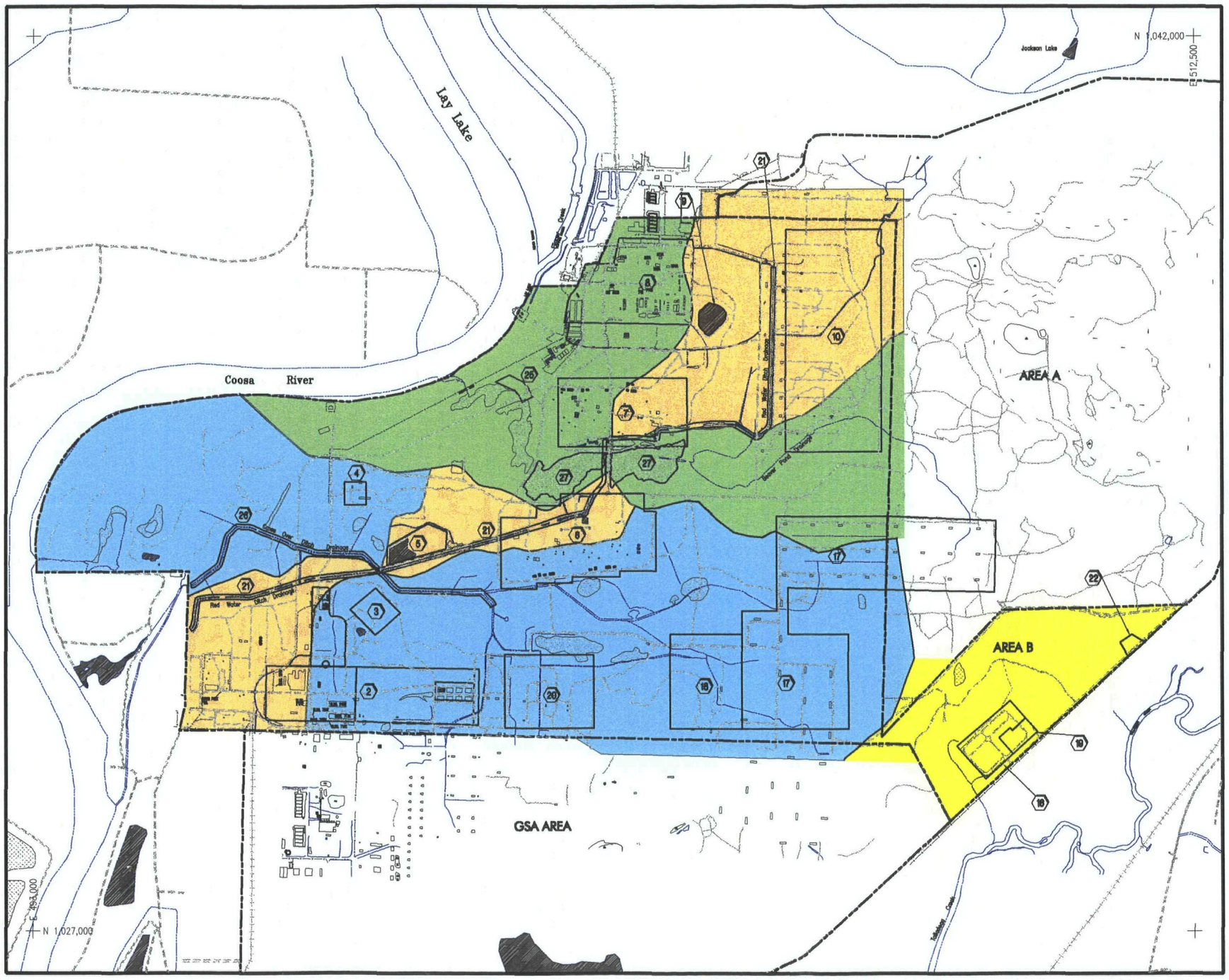


Figure 1. Physiographic provinces of Alabama.

U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

Physiographic Provinces of Alabama

Figure No.	Project No.	File Name	Date
2-1	01-0827-03-8178-045	99015\DWGS\E42F2-1	03-31-99



LEGEND:

- BUILDINGS
- PRIMARY ROADS
- SECONDARY ROADS
- TRAILS
- FENCE
- AREA BOUNDARIES
- STUDY AREAS
- RAIL ROAD
- CREEK, TRIBUTARIES AND RIVER
- WETLANDS
- PONDS, IMPOUNDMENTS
- BEAVER POND DRAINAGE AREA
- RED WATER DITCH DRAINAGE AREA
- CROSSOVER DITCH DRAINAGE AREA
- EAST DRAINAGE AREA
- N 1,042,000 / E 512,500 — GRID BASED ON ALABAMA STATE PLANE EAST

STATE PLANE GRID

0 600 1200 2400

SCALE: 1" = 1200'

U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

ALAAP Drainage Areas
Childersburg, Alabama

Figure No.	Project No.	File Name	Date
2-9	01-0827-03-8178-045	99015\DWGS\E42DRAN	03-31-99

Weather patterns are influenced by a series of southwest to northeast trending valleys and ridges that are associated with the Appalachian mountains. Although the town of Childersburg is far enough inland to be protected from tropical hurricanes, the Gulf of Mexico has a pronounced effect on the climate (NOAA 1993).

Average daily temperatures throughout the year in Talladega County range from 50° to 75°F. Summer temperatures generally range from approximately 70°F at sunrise to 90°F during the afternoon. Extended heat waves with temperatures exceeding 100°F have been recorded every few years. The highest temperatures are recorded in June, July, and August, which are also the most humid months. Winters are generally mild, with mid-December through mid-February being the coldest period. Temperatures below 32°F occur approximately 60 days per year, primarily in December and January (NOAA 1993).

Measured rainfall is fairly well-distributed throughout the year. The 30-year average annual precipitation is 57.38 inches per year (NOAA 1992). The current 5-year annual average precipitation is 54.05 inches per year. The lowest average 30-year monthly rainfall (3.04 inches) historically occurs in October, and the highest average 30-year monthly rainfall (7.04 inches) historically occurs in March. During the Phase 1 Supplemental RI field investigation in February 1995, rainfall was approximately twice the monthly average, measuring 13.53 inches. Historical precipitation data for the period between 1961 and 1990 and recent precipitation data (1994-97) recorded at the Childersburg Water Treatment Plant are presented in **Table 2-1**.

Table 2-1. Monthly Total and Average Precipitation at the Childersburg Water Treatment Plant Alabama Army Ammunition Plant, Childersburg, Alabama

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Precip.
1961-90	5.58	5.32	7.04	5.29	4.63	4.12	4.94	4.19	3.93	3.04	3.92	5.38	57.38
1991-95	5.19	6.85	NA	4.41	3.17	4.29	3.61	NA	NA	NA	NA	NA	NA
1991	4.78	6.31	5.90	1.62	6.75	4.97	3.73	3.29	3.75	1.39	3.76	4.47	50.72
1992	4.85	5.95	2.87M	3.98	1.65	3.02	4.37	4.72	3.03	2.75	7.97	6.21	51.37
1993	8.75	3.14	3.42	3.91	3.41	4.71	0.22	3.39	1.40	2.22	3.14	4.39	42.10
1994	3.49	5.33	7.35	6.14	2.47	6.46	7.98	1.88	5.76	4.04	2.88	5.41	59.19
1995	4.06	13.53	4.99	6.38	1.58	2.30	1.75	5.49	3.49	11.95	6.71	4.66	66.89
1996	9.40	5.02	8.07	2.92	1.11	2.49	4.32	4.94	6.64	4.50	3.38	3.36	56.15
1997	6.75	6.95	2.19	7.70	3.13	8.70	3.14	2.50	3.95	2.96	5.06	4.69	57.72
												5-year average annual precipitation	56.41

Data acquired from the National Oceanic and Atmospheric Administration (NOAA). Data represented from 1961 to 1990 above were acquired from NOAA report – Monthly Station Normals of Temperature, Precipitation, and Heating and Cooling Days, Alabama, 1992.

M – Data missing from NOAA data base during month indicated, a minimum of 20 days recorded.

NA – Data currently not available.

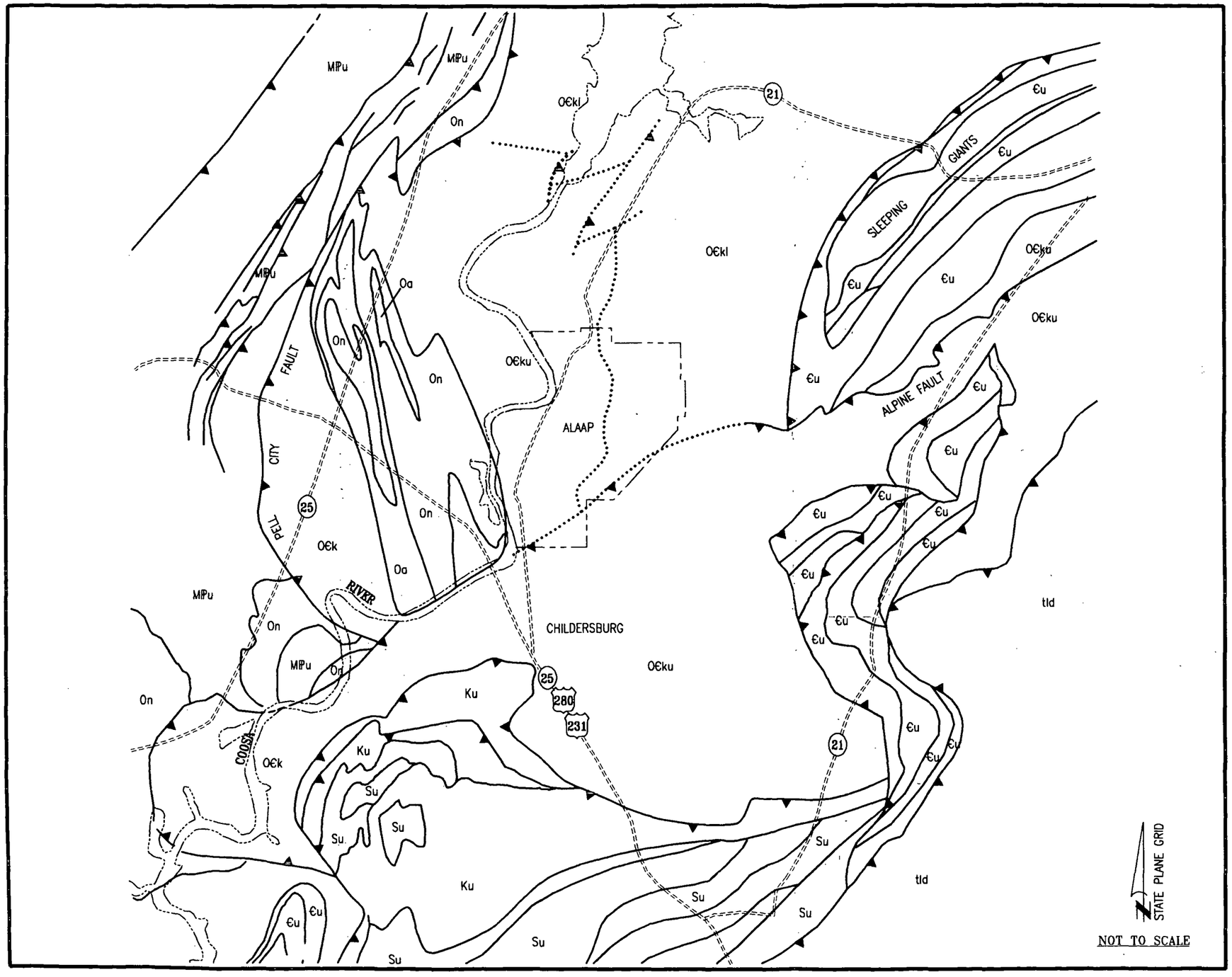
2.4 REGIONAL GEOLOGY

The geologic setting for the ALAAP facility is summarized in the following sections. Information regarding the regional geology was obtained from available literature and mapping of the Alabama Geological Survey (AGS), the U.S. Geological Survey (USGS), the Soil Conservation Service (SCS), and literature compiled from local investigations in the area surrounding ALAAP.

Western Talladega County, including ALAAP, lies within the Appalachian Valley and Ridge physiographic province. The Alabama fold and thrust belt is a region within the Valley and Ridge province that is characterized by Paleozoic rock formations that have been repeatedly folded and thrust faulted by northwestward-directed tectonic stresses. As a result of this deformation, major geomorphic and geologic structures, including fold axes, fault traces, and lithologic boundaries, are commonly oriented in a northeast-southwest direction. Northwestward transport of the Paleozoic rock sequence along thrust faults has resulted in the imbricate stacking of large slabs of rock referred to as thrust sheets. Within an individual thrust sheet, smaller faults may splay off the larger thrust fault, resulting in stacking and overlap of rock units within an individual thrust sheet (Osborne and Szabo 1984). Geologic contacts in the region generally are oriented parallel to mapped faults and repetition of lithologic units is common in vertical sequences. ALAAP lies on the Pell City thrust sheet within the fold and thrust belt.

The Pell City thrust sheet consists of sedimentary rocks of the Cambrian Rome and Conasauga Formations and Cambrian-Ordovician carbonate rocks of the Knox Group **(Figure 2-3)**. Surface geology in the vicinity of ALAAP is mapped as the Cambrian-Ordovician Knox Group (Osborne et al. 1989). To the west along the Pell City thrust fault, rocks of the Pell City thrust sheet are juxtaposed against primarily Mississippian-Pennsylvanian rocks of the Coosa Deformed Belt. The Pell City thrust sheet is over-ridden to the southeast by the Sleeping Giants klippe, which exposes Lower Cambrian rocks of the Chilhowee Group and the Shady Dolomite Formation (Bearce 1978). The Alpine fault extends through the Knox Group from the southern portion of the Sleeping Giants complex along Talladega Creek and truncates the Pell City thrust fault south of ALAAP. Low-grade metamorphic rocks of the Alabama Piedmont occur approximately 10 miles to the southeast.

The Pell City thrust sheet in the vicinity of ALAAP is composed of carbonate rocks and residuum of the Knox Group. Locally, the stratigraphy of the Knox Group is incompletely mapped as a result of deep, differential weathering of the carbonate rocks and the relative absence of exposed formations at the surface. Because of these difficulties, Osborne et al. (1989) informally divided the Knox Group into the upper and lower Knox Groups. Bedrock coring conducted by Southern Company Services at the Logan Martin Dam site (approximately 5 miles north of ALAAP) indicates that the lower Knox Group typically consists of intensely fractured, tan to gray, very fine- to coarse-grained dolomite, with lesser chert, sandstone, and limestone (Redwine 1993). The upper Knox Group consists of dolomite much like that of the lower Knox Group; however, more abundant beds of limestone and sandstone with less chert are interbedded with the dolomite.



LEGEND:

- GEOLOGIC CONTACT
- INFERRED GEOLOGIC CONTACT
- THRUST FAULT
- PROJECTED THRUST FAULT
- INFERRED THRUST FAULT
- PRIMARY ROADS
- MAJOR SURFACE WATER FEATURE

PENNSYLVANIAN / MISSISSIPPIAN

MPu – Mississippian and Pennsylvanian Systems undifferentiated. Locally includes the Parkwood Formation, Floyd Shale, Tuscumbia Limestone, and Fort Payne Chert.

DEVONIAN

tld – Talladega Group undifferentiated (Silurian ? – Devonian)

SILURIAN

ORDOVICIAN

Oa – Athens Shale

On – Newala Limestone

CAMBRIAN

O€k – Knox Group Carbonates (Cambrian – Ordovician) locally differentiated into the Lower Knox Group (O€kl) cherty dolomite regime and the Upper Knox Group (O€ku) limestone dolomite regime.

Su – Sylacauga marble Group (Cambrian? – Ordovician?) locally includes the Jumbo Dolomite, Fayetville Phyllite, Gooch Branch Chert, and the Gants Quarry formation.

€u – Cambrian Series Undifferentiated. Locally includes the Rome Formation, the Shady Dolomite, the Chilhowee Group, the Conasauga Formation and the Weisner and the Wilson Ridge Formations.

PRE-CAMBRIAN

Ku – Kahatchee Mountain Group undifferentiated (Pre-cambrian? – Cambrian?) locally consists of Wash Creek Slate.

SOURCES:

Osborne 1989, Szabo et al. 1988, klidzejs 1994.

U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

Geology Map

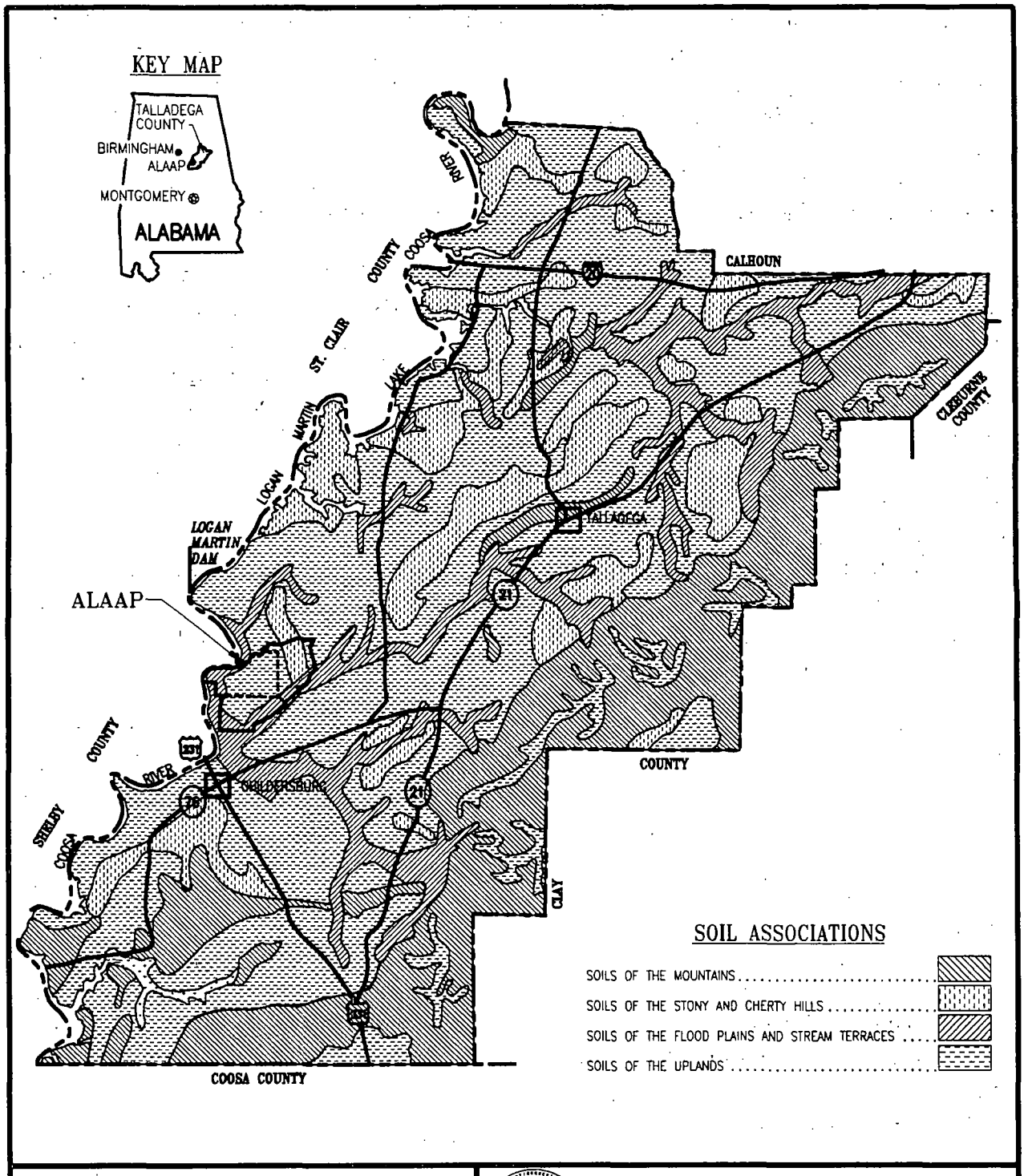
Figure No.	Project No.	File Name	Date
2-3	01-0827-03-8178-045	99015\DWGS\E42GEO	03-31-99

Because of the weathering characteristics of the limestone and the lesser amount of chert, topography overlying the upper Knox Group is generally flat to rolling hills. Topography over the lower Knox Group is characterized by moderate relief due to the predominance of fairly resistant dolomite and the relative abundance of chert (Osborne 1989). Based on mapping completed by Southern Company Services (1989) and resultant topographical relief differences between the upper and lower Knox Groups, Klidzejs (1994) suggested that the contact between the two units extends along a north-south line trending through the approximate center of ALAAP.

Large-scale geologic lineaments trending N80-85°E and N50°W have been mapped on a regional scale from satellite imagery (Guthrie 1993). Detailed photogrammetric and geologic mapping at the Logan-Martin Dam site (Redwine 1993) approximately 5 miles northwest of ALAAP indicated a predominant east-west oriented joint set in the bedrock along which extensive solution activity was occurring. The majority of mapped joint sets at the dam site occurred between N86°E and N82°W with near vertical surfaces dipping to the north. A high-permeability, linear discontinuity was mapped at the dam site trending N60-70°E. Aerial fracture trace mapping in the vicinity of the dam site indicated that the majority of the mapped fractures are oriented between N40°E and N70°W. Klidzejs (1994) analyzed the orientation of rectilinear stream segments in portions of Talladega County and observed an approximately bimodal distribution of stream segments with orientations between N30°E-N50°E and N25°W-N40°W. Klidzejs (1994) also observed prominent lineament orientations from orthophotoquadrangle maps at directions N20°W, N54°W, N31°E, and N47°E.

Relatively few surface exposures of unweathered Knox Group rocks exist in the immediate vicinity of ALAAP because of deep weathering of the carbonate bedrock. Moser (1988) reported that residuum is less than 50 feet thick in most areas of Talladega County, although up to 100 feet of residuum may occur. Drilling records for private groundwater wells installed near ALAAP indicate that up to 120 feet of residuum may be locally present. Typically, residuum over the Knox Group consists of yellowish red to reddish brown clay with abundant fragments of weathered dolomite, limestone, and chert. Residuum in surface exposures appears semi-consolidated or as very weathered bedrock retaining relict primary and secondary structures, such as bedding planes and joints (Klidzejs 1994). The relict structures appear as textural or color contrasts and may impart an oriented, preferential fabric to the residuum mass. Voids or clay-filled voids have been observed in the subsurface at the bedrock residuum interface (ESE 1993). Small sinkholes in Talladega County and in the vicinity of ALAAP provide additional evidence of preferential flow paths within the residuum (Klidzejs 1994).

Soil in the vicinity of ALAAP is categorized into 14 associations that are classified into 4 groupings based on geomorphic setting. The four groupings include soils of the mountain areas, soils of the stony and cherty hills, soils of the floodplains and stream terraces, and soils of the uplands (Cotton et al. 1974). **Figure 2-4** shows the distribution of these soil groupings across Talladega County.



LEGEND:

PRIMARY ROADS

COUNTY BOUNDARY

APPROXIMATE ALAAP BOUNDARY

STATE PLANE GRID

NOT TO SCALE

Source: Cotton et al. 1974

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ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

General Soil Map
Talladega County, Alabama

Figure No.	Project No.	File Name	Date
2-4	01-1033-03-8178-030	99015\DWGS\E42GENS	03-31-99

The mountain area soils include the Tallapoosa-Tatum, Townley-Enders-Montevallo, and Clymer Associations. Soils of these associations are derived from the weathering of slate, phyllite, sandstone, and shale and are typically loamy, well-drained, and occupy short steep slopes, narrow ridge tops, and rock outcrops. The soils of the stony and cherty hills include the Bodine-Minvale Association, derived from the weathering of cherty limestone, and the Allen Association, derived from the weathering of sandstone and shale. These soils are generally deep, well-drained, contain high percentages of gravel and rock fragments, and occupy steep terrains. Soils developed on floodplains and stream terraces include the Chewacla-Chenneby-McQueen and Lobelville-Chewacla-Chenneby Associations. These associations include soils that are deep, well to poorly drained, and loamy. They typically occupy level terrains adjacent to the larger streams within Talladega County. Although productive, use of these soils is sometimes restricted due to poor drainage and flooding. Soils developed in upland areas include the Decatur-Dewey-Fullerton, Bodine-Minvale-Locust, Tatum-Tallapoosa-Wickham, Bremo, Townley, and Allen-Holston-Cane Associations. Soils of these associations are generally loamy at the surface and more clayey with depth. They are deep to shallow, drained to moderately well-drained, and occur on gently sloping to sloping terrains. They are predominantly derived from the weathering of clastic sedimentary and metamorphosed clastic sedimentary rocks.

Soils within ALAAP are included in the Chewacla-Chenneby-McQueen, Decatur-Dewey-Fullerton, and Bodine-Minvale Associations. Each association is composed of individual soil series (e.g., the Minvale series of the Bodine-Minvale Association), which in turn are divided into mapping units (e.g., the Minvale cherty silt loam [MnC] of the Minvale series). **Figure 2-5** illustrates the distribution of soil mapping units within the ALAAP boundaries. **Table 2-2** provides the general characteristics of the soil series and soil mapping units occurring on ALAAP in Talladega County.

2.5 REGIONAL HYDROGEOLOGY

Comparatively few regional studies have been conducted in southwestern Talladega County to determine the direction of regional groundwater flow. Several studies have been conducted to investigate groundwater quality, availability (Causey 1965, Moser 1988), and aquifer productivity. Planert and Pritchett (1989) used information from public supply wells and springs to map regional groundwater flow between Calhoun and Talladega Counties. The results of these studies are summarized below.

Potentiometric data compiled by Planert and Pritchett (1989) indicate that regionally, groundwater in the Knox Group aquifer flows from northeast to southwest between Anniston, Alabama, in Calhoun County and Childersburg, Alabama **(Figure 2-6)**. The data compiled by Planert and Pritchett (1989) were obtained from public supply wells that produce groundwater from deeper bedrock formations. In southwestern Talladega County, groundwater movement is influenced by the Coosa River, which acts as an influent water body on a regional scale.

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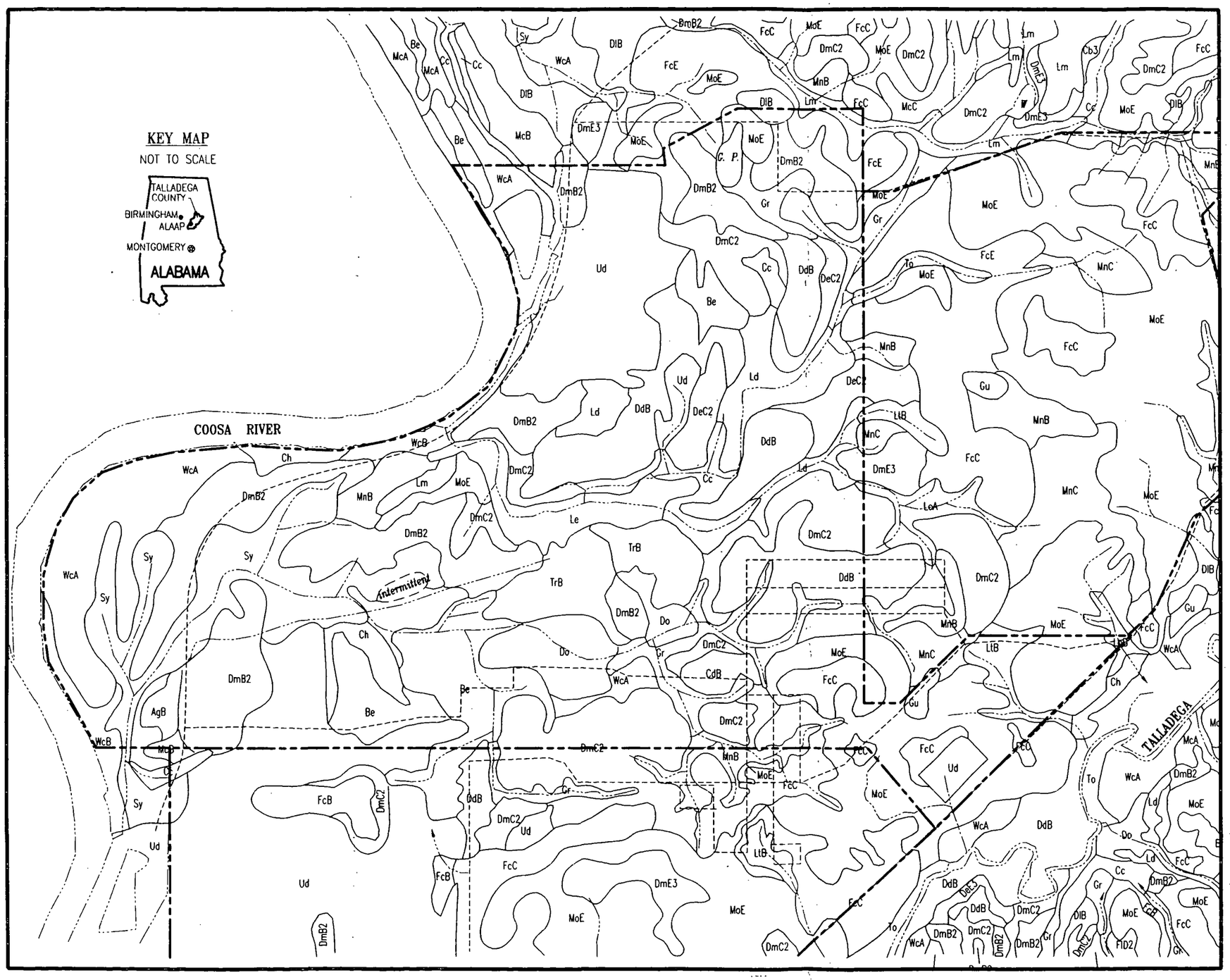

LEGEND:

- TRIBUTARIES
- PRIMARY ROADS
- APPROXIMATE AREA BOUNDARIES

SOIL CLASSIFICATIONS:

Be - Beason Silt Loam
Cc - Chewacla and Chenneby Soils
Ch - Choccolocco Silt Loam
DdB - Decatur Silt Loam, 2-6% slopes
DeC2 - Decatur Silty Clay Loam, 10-25% slopes, severely eroded
DmB2 - Dewey Clay Loam, 2-6% slopes, eroded
DmC2 - Dewey Clay loam, 6-10% slopes, eroded
DmE3 - Dewey Clay Loam, 10-25% slopes, severely eroded
Do - Dowelltton Silt Loam
FcC - Fullerton Cherty Silt Loam, 6-10% slopes
Gr - Grasmere Silty Clay
Gu - Guthrie Silt Loam
Ld - Leadvale Silt Loam
Lm - Lobelville Loam
LoA - Locust Silt Loam, 0-2% slopes
LoB - Locust Silt Loam, 2-6% slopes
LtB - Locust Cherty Silt Loam, 2-6% slopes
MnB - Minvale Cherty Silt Loam, 2-6% slopes
MnC - Minvale Cherty Silt Loam, 6-10% slopes
MoE - Minvale - Bodine Association, hilly
Sy - Sylacauga Silt Loam
To - Toccoa Loams
TrB - Townley Gravelly Loam, 2-6% slopes
Ud - Urban Land - Decatur Complex

Source:

Cotton et al. 1974

STATE PLANE GRID

NOT TO SCALE

U.S. ARMY ENVIRONMENTAL CENTER
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CHILDERSBURG, ALABAMA

Detailed Soil Map
for Areas A & B

Figure No.	Project No.	File Name	Date
2-5	01-0827-03-8178-045	99015\DWGS\E42SOIL	03-31-99

However, the regional data are insufficient to map groundwater movement relative to the Coosa River on a local scale. Regional groundwater elevation ranges from approximately 650 feet msl near Anniston, Alabama, to 400 feet msl near Childersburg, Alabama. Recharge to the groundwater system occurs through the infiltration of precipitation and to a lesser extent by direct flow of surface water or rainfall into sinkholes. Because water table conditions exist, the recharge area may be considered to include the entire areal extent of residuum overlying the Knox Group carbonate bedrock. Recharge has been estimated at approximately 5 inches per year (Planert and Pritchett 1989). Points of groundwater discharge include the Coosa River, various springs, and effluent streams.

Groundwater quality in Talladega County has been investigated by Causey (1965) and Moser (1988). Groundwater quality data collected by Moser (1988) from private wells completed in the Knox Group in Talladega County are summarized in **Table 2-3**. These data also are plotted as percentage reaction values on a trilinear (Piper) diagram in **Figure 2-7**. The Piper diagram is a visual method of characterizing and displaying natural groundwater chemistry based on the presence of the most commonly occurring ionic species. Figure 2-7 indicates that groundwater from Talladega County is characterized as a calcium bicarbonate type, which is typical of limestone regions. Regional groundwater has a pH ranging from 4.8 to 8.2 pH units with an average of 7.54 pH units. Specific conductance averaged 297 µmhos/cm with hardness ranging from 9 to 230 mg/L and averaging 140 mg/L.

2.6 HYDROLOGY

This section describes the hydrologic characteristics of ALAAP and the surrounding area.

2.6.1 Receiving Waters

Surface water flow in the region of ALAAP is directed toward the Coosa River, which is a component of the Mobile River Basin. Major contributing streams to the Coosa River, within the vicinity of ALAAP, include Kelly Creek (approximately 5 miles upstream), Talladega Creek (1.5 miles downstream), and Tallaseehatchee Creek (2.2 miles downstream). Flipper Creek, with tributaries including Little Blue Creek and Fanning Branch, enters the Coosa River at the north end of ALAAP. Tributaries to these creeks generally form dendritic drainage patterns near ALAAP. Further east and west, the geology and subsequent relief of the Piedmont and the Plateau, respectively, produces moderately developed trellis drainage patterns. The major surface water features on and surrounding ALAAP are shown in **Figure 2-8**.

Since 1949, flow on the Coosa River has been regulated by a series of dams constructed for flood control and electrical power generation. As a result, the Coosa River now exists as a series of reservoirs, with the portion adjacent to ALAAP a component of Lay Lake, impounded by Lay Dam. Flow into Lay Lake is controlled by the Logan Martin Dam, which impounds Logan Martin Lake.

Table 2-3. Natural Groundwater Quality in Knox Aquifer - Talladega County
Alabama Army Ammunition Plant, Childersburg, Alabama

Sample	C-13	C-16	C-02	D-1	E-3	E-01	F-5	G-3	G-6	G-14	G-15	G-03	H-5	H-7
Date of Collection	**01/13/86**	**02/27/86**	**01/13/86**	**01/14/86**	**01/21/86**	**01/21/86**	**01/20/86**	**01/14/86**	**01/14/86**	**02/27/86**	**01/23/86**	**01/23/86**	**02/27/86**	**01/16/86**
Well Depth (ft)	260		175	348	211	265	225	85	102		140	60		
Springflow (gpm)										2200			1650	
Specific Conductance (umhos/cm)	385	346	480	208	232	247	230	551	344	237	402	313	231	326
Temperature (°C)	17	16	17	11	14	16	9	15	17	16	12	17	16	17
Bicarbonate (mg/L)	150	210	180	120	150	160	150	220	140	150	140	210	150	130
Alkalinity as CaCO3 (mg/L)	120	170	150	98	120	130	130	180	110	120	110	170	120	110
pH	7.4	7.6	7.4	7.7	7.6	7.3	7.2	7.4	7	8	7.1	7.8	7.8	7.6
Silica (mg/L)	8	6.1	7.6	8	10	8.8	10	7.4	7.3	6.2	6.2	7.8	6.1	8.3
Calcium (mg/L)	36	48	48	22	39	30	29	58	26	25	49	38	28	26
Magnesium (mg/L)	11	14	13	12	8.2	14	12	19	14	14	3.2	21	14	13
Sodium (mg/L)	1.4	2.4	1.8	1.1	1	0.9	1.6	3.6	2.3	1.1	2.6	1.4	0.8	1
Potassium (mg/L)	0.4	0.8	0.9	0.3	1.2	0.6	0.8	2.2	0.7	0.4	0.8	0.2	0.2	0.6
Sulfate (mg/L)	ND	1.4	1.4	ND	1.6	1.8	2.8	7.2	2.8	0.4	1.2	1.2	ND	ND
Chloride(mg/L)	2.6	2.8	2.3	3.7	0.8	0.2	0.8	5	1.8	0.8	3.4	2.5	0.8	0.9
Fluoride (mg/L)	0.02	<0.05	<0.02	<0.02	0.13	<0.02	<0.02	<0.02	<0.02	<0.05	<0.02	<0.02	<0.05	<0.02
Nitrate as N (mg/L)	0.58	1.48	2.4	0.71	0.56	0.31	0.32	3.3	1.3	0.52	2.8	0.92	0.52	0.34
Nitrite as N (mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	1.29	ND	ND	ND	ND	ND
Ammonia as N (mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.01	0.02	ND	ND	0.03
Total Kjeldahl Nitrogen as N(mg/L)	0.14	0.02	0.08	0.06	0.16	0.09	0.21	0.14	0.08	0.06	0.18	0.05	0.26	0.38
Phosphorous as P (mg/L)	ND	ND	ND	ND	ND	0.04	0.01	ND	ND	ND	ND	ND	ND	ND
Orthophosphate as P (mg/L)		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND
Arsenic (ug/L)	1	ND	1	1	ND	ND	ND	1	<0.01	1	1	ND	1	1
Barium (ug/L)	10	10	10	10	40	10	10	30	10	10	20	10	<10	10
Cadmium (ug/L)	ND	ND	<1	ND	<1	<1	<1	<1	ND	ND	ND	<1	ND	<1
Chromium (ug/L)	<1	ND	<1	1	<1	<1	ND	ND	<1	ND	<1	1	ND	<0.5
Cobalt (ug/L)	1	ND	<1	ND	ND	ND	<1	ND	1	ND	1	ND	ND	ND
Iron (ug/L)	20	10	10	20	110	400	20	680	20	20	30	20	20	80
Lead (ug/L)	20	ND	<1	ND	<1	10	1	1	ND	ND	<1	1	ND	5
Manganese (ug/L)	ND	<5	ND	<5	20	10	5	90	ND	ND	ND	<5	ND	ND
Mercury (ug/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Selenium (ug/L)	ND	3	ND	ND	1	4	ND	ND	ND	1	ND	1	10	ND
Silver (ug/L)	<1	ND	ND	1	1		ND	1	<1	<1	<1	1	<1	ND
Strontium (ug/L)	20	40	40	10	40	30	60	40	10	20	80	20	20	40
Zinc (ug/L)	500	<5	<5	50	60	430	460	60	20	10	30	10	<5	80
Total Dissolved Solids (mg/L)	136	186	175	109	138	137	132	226	130	124	147	180	126	115
Hardness as CaCO3 (mg/L)	140	180	170	100	130	130	120	230	120	120	140		130	120

Data obtained from "Groundwater Availability in Talladega County, Alabama", Geological Survey of Alabama Special Map 207, 1988.

Table 2-3. Natural Groundwater Quality in Knox Aquifer - Talladega County Alabama Army Ammunition Plant, Childersburg, Alabama (continued)

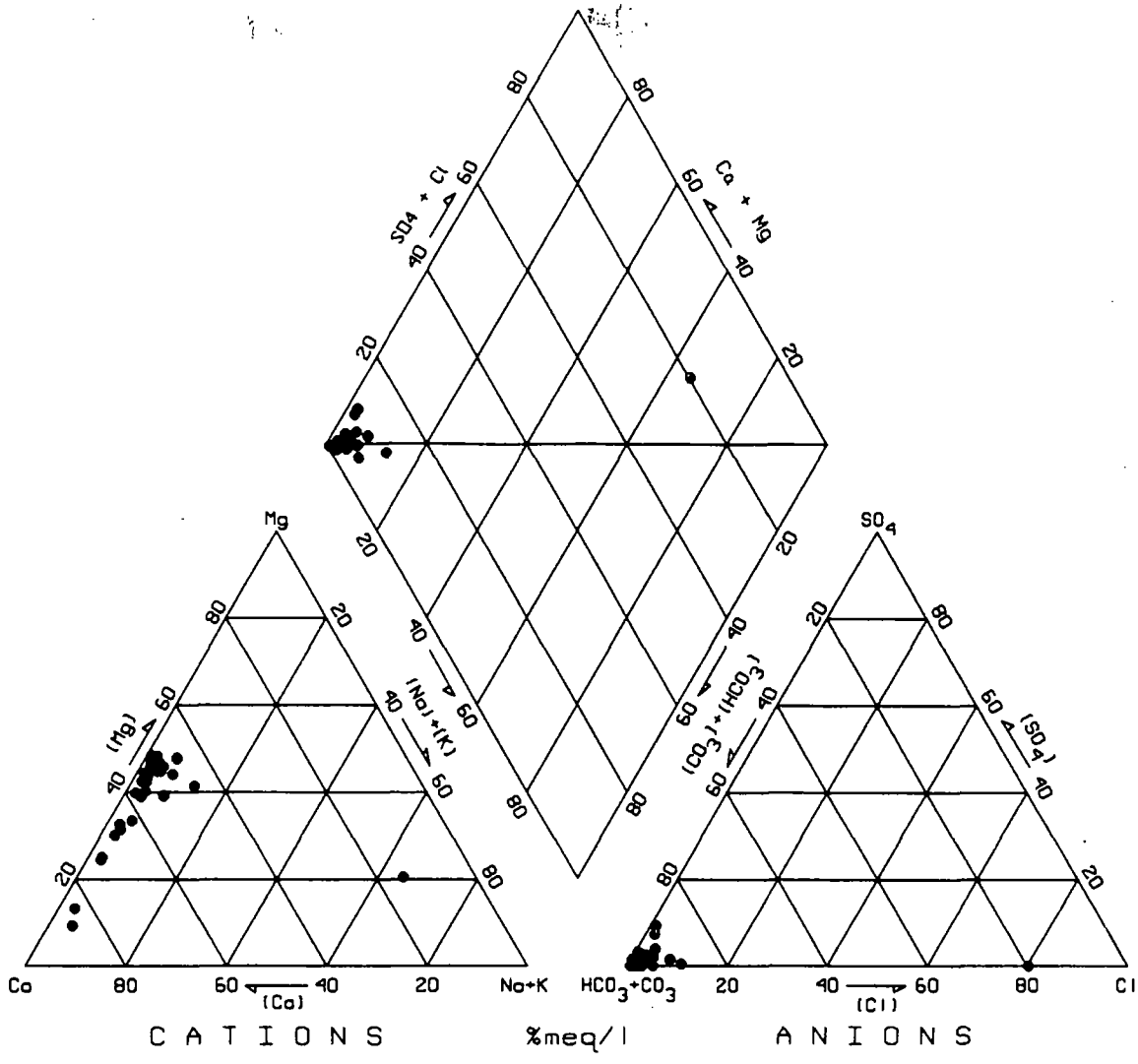
Sample	H-01	I-6	K-4	L-5	L-12	M-2	M-01	N-6	N-14	R-2	R-3	R-7	S-18	T-3
Date of Collection	01/15/86	01/16/86	01/30/86	01/30/86	02/27/86	01/23/86	01/24/86	02/27/86	01/21/86	02/27/86	02/02/86	02/26/86	03/25/86	01/30/86
Well Depth (ft)	80	136	165	148		200	92		85		56	235	185	100
Springflow (gpm)					650			600		600				
Specific Conductance (umhos/cm)	638	223	220	220	224	260	70	257	291	265	413	285	208	260
Temperature (°C)	15	16	14	14	16	16	16	17	16	17	13	13		14
Bicarbonate (mg/L)	240	130	140	140	140	160	3	160	170	170	270	180	130	150
Alkalinity as CaCO3 (mg/L)	200	110	110	110	110	130	2	130	140	140	220	150	110	120
pH	7.4	7.9	7.6	7.6	7.6	7.9	4.8	8.1		7.9	7.9	7.8	6.8	7.1
Silica (mg/L)	7.4	8	7.8	7.4	7	7.4	8.4	5.4	7.8	6	4.4	6.8	7.4	8.4
Calcium (mg/L)	44	25	26	25	25	28	1.4	27	32	30	43	31	24	31
Magnesium (mg/L)	24	14	14	14	13	16	1.2	16	17	16	25	17	13	14
Sodium (mg/L)	9.8	1	1.1	1.3	1.1	2	6.7	1.2	2.6	1.1	0.7	1.4	1.1	5
Potassium (mg/L)	0.9	0.2	0.2	0.3	1.7	0.2	0.8	0.2	0.5	0.4	0.2	0.4	0.3	0.6
Sulfate (mg/L)	0.5	1	ND	ND	ND	1	ND	ND	1.3	0.7	ND	ND	ND	3
Chloride(mg/L)	10	1	0.8	2	1.1	2	7.1	1.5	3	1	0.8	1.8	1.6	2.2
Fluoride (mg/L)	<0.02	<0.02	<0.02	ND	0.06	<.02	0.03	<0.05	<0.02	<0.05	0.06	<.05	2	<.02
Nitrate as N (mg/L)	1.5	0.4	0.36	0.68	0.2	0.65	3.4	0.88	2.1	0.48	0.11	0.82	0.2	0.55
Nitrite as N (mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ammonia as N (mg/L)	0.05	ND	ND	ND	0.01	ND	0.01	ND	ND	ND	ND	ND	ND	ND
Total Kjeldahl Nitrogen as N(mg/L)	0.28	0.13	ND	ND	0.08	0.44	0.16	0.18	0.09	0.07	0.26	0.22	ND	ND
Phosphorous as P (mg/L)	ND	ND	ND	ND	0.01	0.01	ND	ND	ND	0.01	ND	ND	0.01	ND
Orthophosphate as P (mg/L)	ND		ND	ND	0.01	0.01	ND	ND	ND	ND	ND	ND	0.01	ND
Arsenic (ug/L)	1	ND	<0.5	ND	1	ND	ND	ND	ND	1	2	1	1	ND
Barium (ug/L)	30	10	10	<10	10	10	110	<10	10	ND	10	<10	10	10
Cadmium (ug/L)	ND	<1	<1	<1	1	ND	<1	0.5	ND	9	<.5	<.5	3	1
Chromium (ug/L)	<0.5	ND	1	<1	5	1	<1	<0.5	1	1	<.5	<.5	1	1
Cobalt (ug/L)	ND	1	ND	ND	ND	ND	2	1	1	ND	1	<1	ND	1
Iron (ug/L)	60	80	30	10	30	60	60	30	70	10	50	10	30	290
Lead (ug/L)	3	3	1	1	ND	1	<1	ND	1	<1	1	1	1	2
Manganese (ug/L)	ND	6	ND	<5	ND	50	160	20	90	<5	<5	ND	10	ND
Mercury (ug/L)	ND	ND	ND	ND	ND	1	ND	ND	ND	ND	ND	ND	ND	ND
Selenium (ug/L)	1	ND	3	4	2	1	1	2	1	2	ND	4	2	2
Silver (ug/L)	<1	ND	ND	<1	ND	1	1	ND	ND	ND	<1	<1	ND	ND
Strontium (ug/L)	20	10	20	10	20	20	10	20	10	20	20	20	20	30
Zinc (ug/L)	140	30	20	80	10	170	10	<5	80	<5	150	110	40	60
Total Dissolved Solids (mg/L)	221	116	120	122	119	138	42	134	149	141	208	151	114	140
Hardness as CaCO3 (mg/L)	210	120	120	120		140	9	130	150	140		150	110	140

Data obtained from "Groundwater Availability in Talladega County, Alabama", Geological Survey of Alabama Special Map 207, 1988.

Table 2-3. Natural Groundwater Quality in Knox Aquifer - Talladega County Alabama Army Ammunition Plant, Childersburg, Alabama (continued)

Sample	T-4	U-2	V-2	V-13	V-14	V-17	V-06	W-5	W-11	W-17	W-23	W-02	CC-3
Date of Collection	01/31/86	02/04/86	01/31/86	02/04/86	02/27/86	02/27/86	03/21/86	02/04/86	02/05/86	02/27/86	02/28/86	02/07/86	02/25/86
Well Depth (ft)	379		396	70			300	84				177	46
Springflow (gpm)					600	200				860	4		
Specific Conductance (umhos/cm)	280	320	300	280	235	354	280	280	210	276	314	290	387
Temperature (°C)	11	17	14	17	16.5	16	17	17	16	17	16	17	16
Bicarbonate (mg/L)	160	190	180	160	140	200	170	140	130	170	190	170	190
Alkalinity as CaCO3 (mg/L)	130	160	150	130	110	160	140	110	110	140	160	140	160
pH	7.7	7.8	7.5	7.8	8.1	7.4	7.6	7.6	7.8	8.2	7.6	7.8	7.4
Silica (mg/L)	7.9	7.2	8	6.6	6.1	5.6	7.9	6	7.6	6.9	7.2	8.4	6
Calcium (mg/L)	36	37	49	31	27	60	34	29	24	32	30	32	38
Magnesium (mg/L)	15	19	10	17	13	5.8	16	16	13	14	19	18	21
Sodium (mg/L)	1.1	1.6	1.5	2.6	1.2	2.3	1.7	4	1	1.8	3.9	2.9	12
Potassium (mg/L)	0.7	0.3	1.1	0.9	0.5	0.6	0.6	1.8	0.8	1.2	1.4	0.8	0.7
Sulfate (mg/L)	13	12	2.8	2	ND	3.4	ND	1.7	3	3.4	3.2	4.4	0.7
Chloride(mg/L)	1	2.2	1.2	3.6	1.2	2.8	2	7	1.1	2	4.8	0.38	13
Fluoride (mg/L)	0.06	<.02	<.02	<.02	<.05	<.05	0.09	<.02	0.04	<.05	<.05	0.05	<.05
Nitrate as N (mg/L)	0.16	0.77	0.96	2.85	0.3	0.68	1.07	4.28	0.08	0.5	1.18	0.95	6
Nitrite as N (mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0	ND
Ammonia as N (mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.8	ND	ND
Total Kjeldahl Nitrogen as N(mg/L)	0.12	0.02	0.12	ND	0.02	0.03	0.04	0.03	ND	0.08	0.16	0.26	0.32
Phosphorous as P (mg/L)	ND	ND	ND	ND	0.02	ND	ND	ND	0.02	0.01	0.01	ND	0.01
Orthophosphate as P (mg/L)	ND	ND	ND	ND	0.01	ND	ND	ND	0.02	0.01	ND	ND	0.01
Arsenic (ug/L)	ND	3	ND	2	1	1	1	2	1	1	1	2	1
Barium (ug/L)	20	10	30	20	<10	10	10	10	<10	10	10	10	20
Cadmium (ug/L)	1	1	1	1	2	<0.5	1	ND	ND	<5	2	ND	<.5
Chromium (ug/L)	1	2	1	1	<.5	1	1	1	2	<5	1	1	0.5
Cobalt (ug/L)	1	ND	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Iron (ug/L)	60	250	40	490	20	80	400	30	10	90	10	30	900
Lead (ug/L)	1	1	3	1	<1	1	5	1	1	<1	<1	1	3
Manganese (ug/L)	ND	30	ND	60	<5	10	170	5	<5	40	ND	<5	5
Mercury (ug/L)	ND	ND	ND	ND	ND	ND	0.16	ND	ND	ND	ND	ND	ND
Selenium (ug/L)	3	2	6	3	1	5	3	ND	2	3	2	3	ND
Silver (ug/L)	1	ND		ND	ND	ND	1	ND	ND	ND	ND	ND	<1
Strontium (ug/L)	60	20	60	20	40	70	30	30	20	100	20	20	20
Zinc (ug/L)	170	30	1100	70	<5	10	50	50	60	10	10	10	68
Total Dissolved Solids (mg/L)	154	176	ND	150	119	182	151	173	115	147	168	158	212
Hardness as CaCO3 (mg/L)	150	170	167		120	170	150	140	110	140	150	150	180

Data obtained from "Groundwater Availability in Talladega County, Alabama", Geological Survey of Alabama Special Map 207, 1988.



DATA OBTAINED FROM " GROUNDWATER AVAILABILITY IN TALLADEGA COUNTY, ALABAMA ", MOSER 1986.

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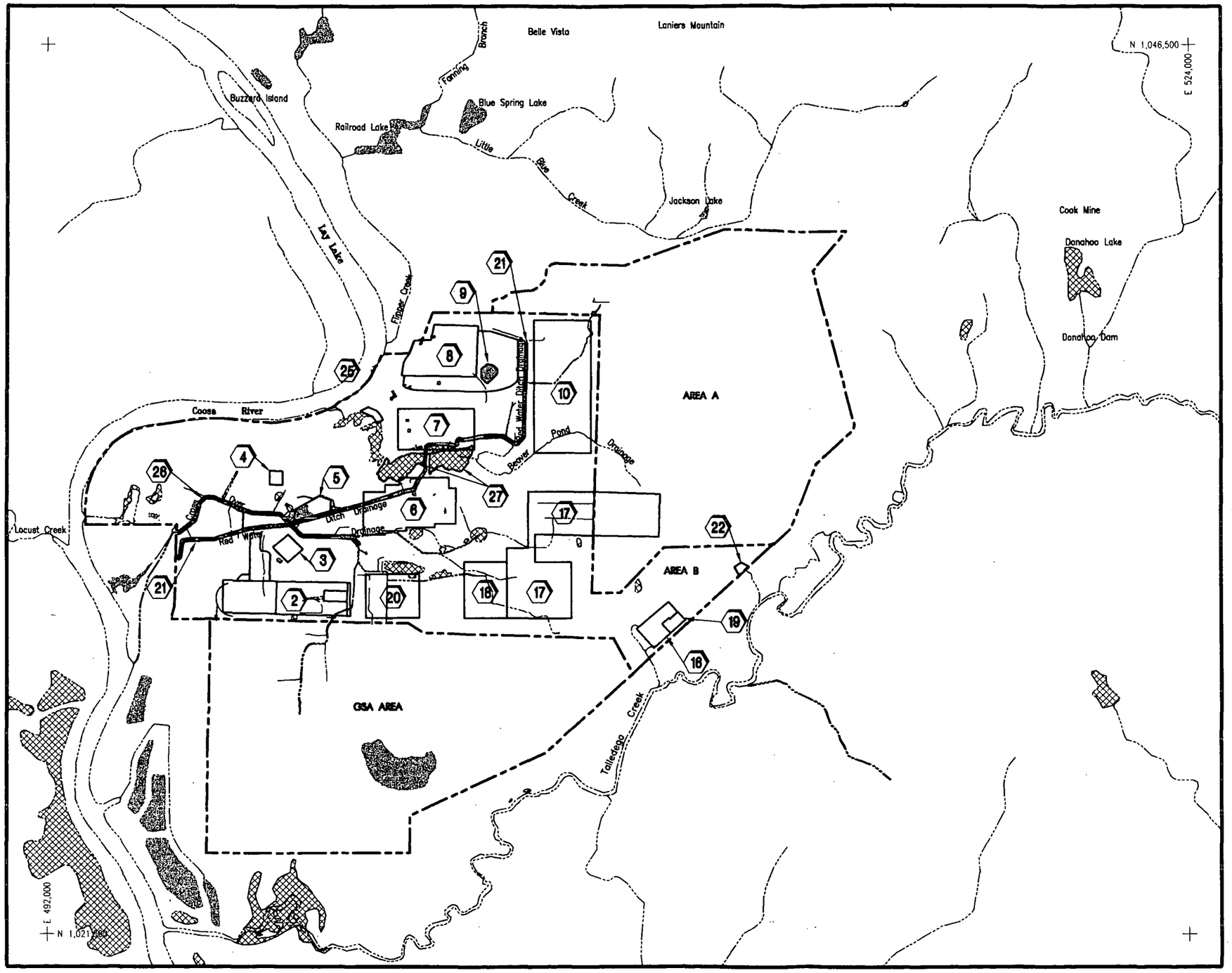
CHILDERSBURG, ALABAMA

Groundwater Quality (Piper) Diagram
Talladega County, Alabama

Figure No.	Project No.	File Name	Date
2-7	01-0827-03-8178-045	99015\DWGS\E42F2-7	03-31-99



LEGEND:

- AREA BOUNDARIES
- (27) STUDY AREAS
- CREEK, TRIBUTARIES AND RIVER
- WETLANDS
- PONDS, IMPOUNDMENTS
- N 1,046,500 / E 524,000 GRID BASED ON ALABAMA STATE PLANE EAST

STATE PLANE GRID

0 1000 2000 3000 6000

SCALE: 1" = 3000'

U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

ALAAP Surface Water Features
Childersburg, Alabama

Figure No.	Project No.	File Name	Date
2-8	01-0827-03-8178-045	99015\DWGS\E42SURFW	03-31-99

The portion of the Coosa River adjacent to ALAAP is gaged at Childersburg (approximately 4 miles downstream from ALAAP). At that station, the average discharge over a 65-year reporting period is 13,860 ft^3/sec. Extremes include a maximum discharge of 150,000 ft^3/sec (April 14, 1979) and a minimum discharge of 378 ft^3/sec (April 20, 1975). Discharges from Logan Martin Dam range daily from 0 to 30,000 ft^3/sec (USGS 1994).

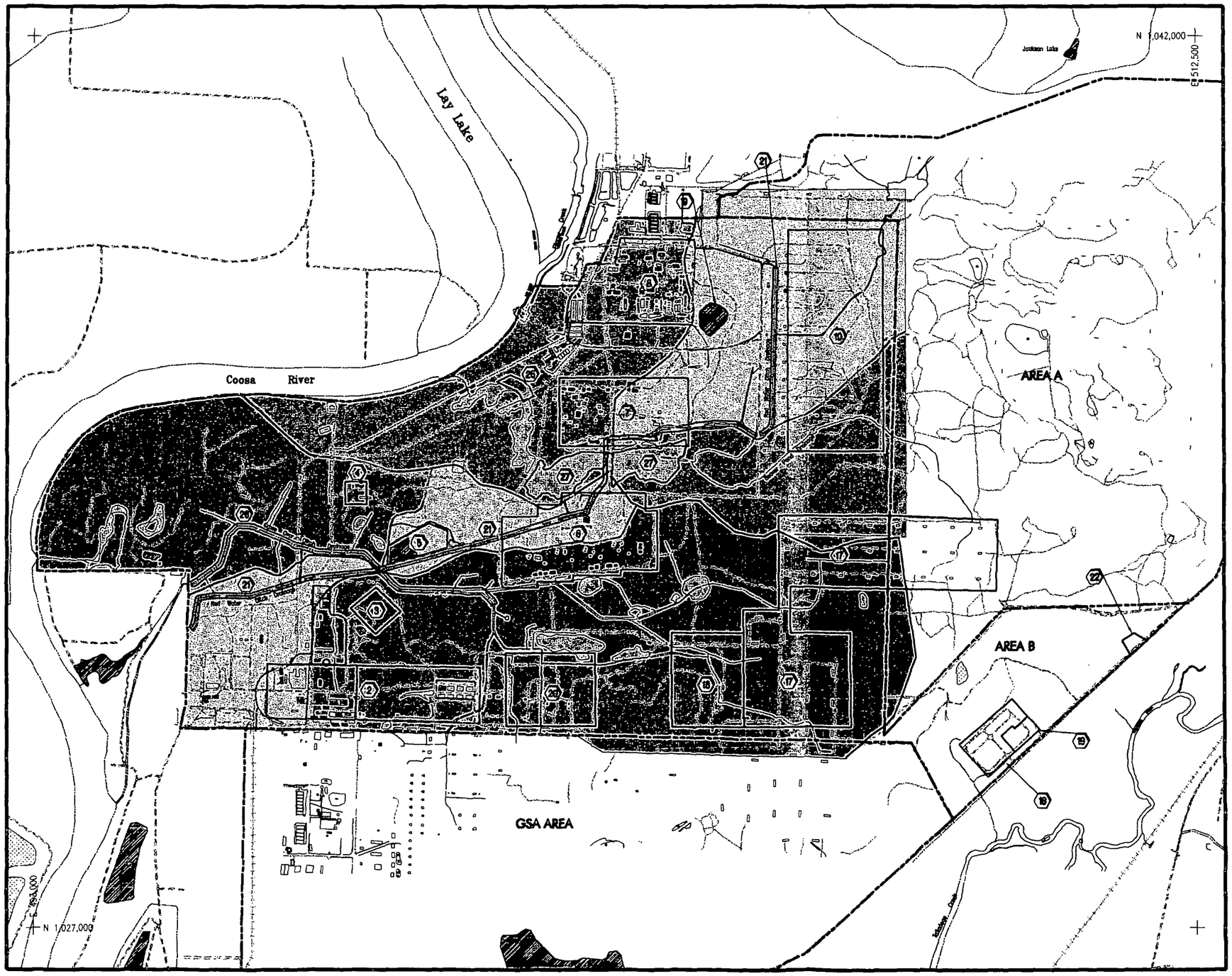
Flow in unregulated streams in the region of ALAAP is variable and dependent upon annual climatic and local geologic conditions. Annually, the lowest stream flows occur in October when rainfall is at a minimum. During November and December, flow increases as evapotranspiration decreases and precipitation increases. Stream flow is greatest between January and April as heavy precipitation continues and runoff is greatest due to saturated soil conditions. During May and June, flow recedes as rainfall diminishes and evapotranspiration increases. Flow rises in July and August due to frequent convectional thunderstorms and then recedes from mid-August to October as rainfall again becomes less frequent (Harkins 1972).

2.6.2 Drainage Characteristics

The present surface water drainage system at ALAAP is a product of natural topography, channelization, and natural and manmade impoundment processes. The site generally slopes (3.5 percent average) west or southwest toward the Coosa River. Therefore, the surface runoff from ALAAP also drains either west or southwest into the Coosa River. The portion of Area B that includes the Flashing Ground (Study Area 16), Lead Facility (Study Area 19), and Demolition Landfill (Study Area 22) lies southeast of a northeast trending ridge that acts as a surface water divide separating flow between the Coosa River and Talladega Creek. Portions of ALAAP southeast of this divide drain into Talladega Creek, which ultimately flows into the Coosa River.

Prior to the construction of ALAAP, the area consisted of farms, woodlands, and wetlands, and much of the western portion of ALAAP was poorly drained (ESE 1993). During facility operations, two natural drainages (the Crossover Ditch and the Beaver Pond Drainage) were channelized or modified to direct runoff to the Coosa River. A manmade channel (the Red Water Ditch) was constructed to transport liquid process wastes to the Coosa River. In addition, two storage basins (the Aniline Sludge Basin [Study Area 9] and the Red Water Storage Basin [Study Area 5]) were constructed to hold process wastes. Since the beginning of demolition activities in 1973, swampy and ponded areas have developed throughout ALAAP primarily due to the construction of beaver dams (ESE 1993). The primary surface drainages at ALAAP include the Red Water Ditch drainage, the Crossover Ditch, and the Beaver Pond drainage. **Figure 2-9** defines the drainage areas.

As originally constructed, the Red Water Ditch extended from the western boundary of Study Area 10 to an outfall at the Coosa River. The drainage was constructed to transport process wastes and surface runoff from facilities in the Southern and Northern TNT Manufacturing Area (Study Areas 6 and 7), the Acid/Organic Manufacturing Area (Study Area 8), and Study Area 10.



LEGEND:

- BUILDINGS
- PRIMARY ROADS
- SECONDARY ROADS
- TRAILS
- FENCE
- AREA BOUNDARIES
- STUDY AREAS
- RAIL ROAD
- CREEK, TRIBUTARIES AND RIVER
- WETLANDS
- PONDS, IMPOUNDMENTS
- BEAVER POND DRAINAGE AREA
- RED WATER DITCH DRAINAGE AREA
- CROSSOVER DITCH DRAINAGE AREA
- EAST DRAINAGE AREA
- N 1,042,000 / E 512,500 — GRID BASED ON ALABAMA STATE PLANE EAST

STATE PLANE GRID

0 600 1200 2400

SCALE: 1" = 1200'

U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

ALAAP Drainage Areas
Childersburg, Alabama

Figure No.	Project No.	File Name	Date
2-9	01-0827-03-8178-045	99015\DWGS\E42DRAN	03-31-99

In addition, overflow from Study Area 5 and drainage from industrial sewer systems throughout ALAAP were conveyed to this drainage. Along its path, the drainage crosses the Beaver Pond Drainage System (Study Area 27) and the Crossover Ditch. At these areas, water from the Red Water Ditch is diverted through large-diameter vitrified culverts. Water flow in the Red Water Ditch is sustained only during the wettest periods of the year. Generally, water occurs as shallow standing pools. During dry periods, water occurs only intermittently. The Red Water Ditch drainage system conveys approximately 17 percent of the surface water within ALAAP (ESE 1981).

The Crossover Ditch was a natural drainage that was modified to convey surface runoff and wastewater from the nitrocellulose (NC) and propellant manufacturing areas, the southern power plant, and the propellant finishing areas. Tributaries of the ditch extend approximately from the southern boundary of Area B. The ditch flows north and west through ALAAP, then south to an outfall at the Coosa River. During most of the year, water in the Crossover Ditch occurs in shallow runs and in pools behind beaver dams. Significant flow occurs only during the wettest periods of the year, and during dry periods, water occurs only intermittently. The Crossover Ditch system drains approximately 25 percent of ALAAP.

The Beaver Pond Drainage System occupies a natural topographic low, which extends from the western side of the Talladega Creek/Coosa River drainage divide to the Coosa River. During operations at ALAAP, the stream system was channelized between Study Area 10 and Study Areas 6 and 7. West of Study Areas 6 and 7, the drainage system is within the Coosa Valley floodplain and has not been modified (ESE 1983). Two large beaver ponds, which store large volumes of water, currently exist within the drainage. Flow within most of Study Area 27 is sustained throughout the year, although flow in the upper reaches becomes intermittent during dry periods. Study Area 27 conveys approximately 25 percent of the surface waters within ALAAP.

Standing water features at ALAAP include two manmade basins and numerous ponds and wetlands formed behind beaver dams. Study Area 9 was constructed as a clay holding basin with an industrial outfall and no outlet. It was used to store residues from Study Area 8. The basin contains standing water most of the year, but is dry during the driest periods.

The Red Water Storage Basin was constructed as a settling pond for process waters from the trinitrotoluene (TNT) manufacturing process. The floor and dikes of the basin were constructed of hard clay. The basin originally was equipped with an entry pipe and exit flume. Study Area 5 contains water most of the year, but is dry during the driest periods.

Ponded/marshy areas exist throughout ALAAP. The largest of these areas include the two beaver ponds within the Beaver Pond Drainage System and beaver ponds south and east of Study Area 6, and north and east of the Rifle Powder Finishing Area (Study Area 20) within the Crossover Ditch Drainage System.

2.7 VEGETATION AND HABITATS

This section discusses the vegetation and plant habitats in the region and at ALAAP. Specific discussion of ALAAP wetlands and the potential for the occurrence of threatened and endangered (T&E) plant species at ALAAP is included.

2.7.1 Regional Vegetation and Habitats

Regional vegetation refers to an area composed of most of Alabama and most of Georgia. Eastern central Alabama is an area that transitions between the southern Appalachian Mountains and the piedmont. The regional vegetation follows this pattern of transition, grading between oak-pine forests (Appalachian) and forests dominated by pines (piedmont) in areas that are not under cultivation. Cotton and soybeans are major crops, with considerable acreage being dedicated to these cultivars in level to rolling areas.

Regional forests are typically loblolly-shortleaf pine associations and loblolly pine-hardwood associations (SAF 1980). Loblolly pine (*Pinus taeda*) is a major component of both types. Associated species within these two forest cover types vary with moisture availability and topography. On well-drained sites, longleaf (*P. palustris*), shortleaf (*P. echinata*), and Virginia pines (*P. virginiana*) are found along with southern red (*Quercus falcata*), white (*Q. alba*), post (*Q. stellata*), and blackjack oaks (*Q. marilandica*). Hickories (*Carya* spp.), sweetgum (*Liquidambar styraciflua*), sassafras (*Sassafras albidum*), and persimmon (*Diospyros virginiana*) also are commonly found. Moderately to poorly drained sites support associated red maple (*Acer rubrum*), blackgum (*Nyssa sylvatica*), willow (*Salix* spp.), water (*Q. nigra*), and cherrybark oaks (*Q. falcata* var. *pagodifolia*), and yellow poplar (*Liriodendron tulipifera*).

On somewhat poorly drained flatwoods, loblolly pine stands often replace longleaf pine stands after the longleaf pines are harvested. Loblolly pine also will colonize abandoned fields, cut-over or burned areas, and other areas of disturbance. Loblolly pine is only moderately shade-tolerant, and therefore, tends to be successionally temporary. In the absence of repeated disturbance, such as heavy logging or fire, hardwood species will eventually replace the pine. Succession on drier sites is toward upland oaks. On wetter sites, tree species such as sweetgum, water oak, and other hardwoods will supplant the pine. Thus, within the loblolly pine-hardwood stands, succession is strongly toward hardwoods.

Understory trees include black cherry (*Prunus serotina*), flowering dogwood (*Cornus florida*), American holly (*Ilex opaca*), sassafras, hawthorns (*Crataegus* spp.), sourwood (*Oxydendron arboreum*), fringetree (*Chionanthus virginiana*), redbay (*Persea borbonia*), sweetbay (*Magnolia virginiana*), and sweetleaf (*Symplocos tinctoria*). Commonly associated shrubs are beautyberry, yaupon, southern bayberry, gallberry, and pepperbush, along with woody vines such as Japanese honeysuckle (*Lonicera japonica*), poison ivy (*Rhus radicans*), grapes (*Vitis* spp.), and greenbrier (*Smilax* spp.).

2.7.2 ALAAP Vegetation and Habitats

ALAAP consisted of farms and forests when purchased by the Federal Government, with most of the forested areas having been logged before the facility was constructed. Some areas of the site were not likely disturbed during the construction or operation of ALAAP (ESE 1993). These areas, left as is or to revert to natural succession, contribute to the current vegetation and habitat patterns at ALAAP. Paved roads, rail lines, and production and storage facilities still exist, but are in various stages of disrepair. Several drainage ditches created during site construction and operation (Red Water Ditch and Crossover Ditch) cross the site. Logging operations have continued under a managed forestry program since the facility ceased operation (ESE 1986).

Five broad types of plant communities/habitats are found onsite and include old field communities, pines, hardwood swamps, mixed upland hardwoods, and bottomland hardwoods. The plant communities/habitats are found scattered throughout Area B. A habitat map provided in Section 7 shows precisely where habitats are located. These plant communities are greatly influenced by the onsite soils that range from well-drained shaly silt-loams to silt loams with associated periods of standing water. Additional habitats found onsite are wetlands, discussed separately in Section 2.7.3, and open water habitats, which include ponds (west and east Beaver Ponds) and streams (especially tributaries to Crossover Ditch and the Beaver Ponds).

Old Field Communities—Many areas have been clearcut and not replanted, resulting in open fields. The first few years of regrowth in these open fields are dominated by herbaceous plants; this stage of succession is referred to as early sere old field. After several years of regrowth, trees, shrubs, and woody vines began to gain dominance. Dominant trees in these relatively open fields include loblolly pine, sweetgum, black cherry, sassafras, and southern redcedar (*Juniperus silicicola*). Dominant shrubs include chickasaw plum (*Prunus angustifolia*), smooth sumac (*Rhus glabra*), and deerberry (*Vaccinium stamineum*). Vines and herbaceous cover include Japanese honeysuckle, wild rose (*Rosa* spp.), blackberries (*Rubus* spp.), and blue vervain *(Verbena hastata)*. The old field communities generally are found in cleared portions of Study Areas 6, 7, and 10.

The same type of plant associations occur in areas, such as Study Area 8, occupied by abandoned production and support structures that made up the facility. These areas, with vegetation slowly reclaiming manmade structures and sites, are known as ruderal communities. The abandoned structures, whether intact or in rubble, often contribute to wildlife habitat by providing escape, resting, or nesting cover.

Pines—Pines are represented by remnants of selectively cut stands, younger stands of naturally regenerated pine, and pine plantations. Dominant trees in the pines include loblolly pine, Virginia pine, spruce pine (*P. glabra*), southern redcedar, and southern red oak. Corings of loblolly pines of various-sized trees (up to 31.5 inches diameter at breast height [DBH]) show that the largest trees onsite are approximately 50 to 60 years old. Pine areas are found mostly in the eastern portion of Area B.

Mixed Upland Hardwoods—The higher elevations support slightly different plant communities because of their better-drained soils. Most of the eastern areas have been heavily logged (ESE 1993) in the past, with remaining stands being relatively dense. These forests are a dominant part of the habitat mix at ALAAP. Prevalent species include black oak, blackjack oak, southern red oak, yellow poplar, hickories, loblolly pine, and Virginia pine. Dogwood is a common understory tree. Shrubs include plums and blueberries (*Vaccinium* spp.). Ground cover, sparse in many of these stands because of the heavy leaf litter, includes partridgeberry (*Mitchella repens*), heartleaf, bedstraw, Japanese honeysuckle (*Lonicera japonica*), bluets, and wintergreen (*Chimaphila maculata*).

Bottomland Hardwoods—More level areas at intermediate elevations have soils that are moist, consisting of deep, moderately well-drained cherty material. Bottomland hardwood species with occasional pines dominate these areas that are present as borders to the Coosa River, the hardwood swamps, and other wetlands. Species include red oak, white oak, sweetgum, American beech, hickories, water oak, and laurel oak. Dogwood is common within the understory. Shrubs include deerberry, blueberry, blackberry, possum haw, and chickasaw plum. Ground cover includes partridge berry, clover, elephant's foot, sphagnum, spider-wort, bird's-foot violet, heartleaf, bedstraw, and snakeroot.

2.7.3 Wetlands

Wetlands at ALAAP fall into four general vegetational classes: open water, hardwood swamps, scrub-shrub-dominated swamps, and emergent marshes. Vegetational development depends largely upon the depth and duration of flooding. Because of annual drawdown from evapotranspiration, most wetlands exhibit components of two or more of the vegetational classes. Several wetlands at the site contain water year-round, but most wetlands experience a significant dry period during the summer and fall. Open water wetlands occur primarily in the Beaver Ponds where water is present throughout the year at depths greater than approximately 1.5 feet. Trees, shrubs, and emergent herbaceous species are able to invade sites where drawdown is sufficient to allow seedlings to become established. Several large permanently inundated wetlands at ALAAP developed in areas where beavers have dammed small creeks and drainage ditches at the site (Study Area 27). Most of the other wetlands at the site have developed naturally along the stream channels and floodplains of Talladega and Little Blue Creeks that experience temporary flooding and soil saturation during the growing season.

Tree species frequently encountered in ALAAP wetlands include willow, red maple, Carolina ash (*Fraxinus caroliniana*), sweetgum, American sycamore (*Platanus occidentalis*), water oak (*Quercus nigra*), winged elm (*Ulmus alata*), eastern cottonwood (*Populus deltoides)*, bluff oak (*Q. austrina*), and various pines. Common shrubs include buttonbush, smooth sumac, and various seedlings and saplings of local trees. Herbaceous species include needle rush (*Juncus roemerianus*), bulrush (*Scirpus* spp.), various grasses, and other herbaceous plants. It is not known if ALAAP wetlands have been delineated in accordance with procedures and methods described in the *Army Corps of Engineers Wetland Delineation Manual* (Environmental Laboratory 1987).

Prior to occupancy of the site by the U.S. Army, the site probably contained several large natural wetland systems as part of the Coosa River floodplain, but the pre-existing wet areas were drained to prepare the site for construction of the ALAAP facilities (ESE 1986). Wetlands currently occupy a total area of approximately 64 acres in Area B. Individual wetlands range from 0.1 to 14.2 acres. No specific functional analysis of wetlands at ALAAP has been conducted. However, wetlands at ALAAP provide for the retention of sediment and provide important habitat elements for beaver, various amphibians, reptiles, aquatic invertebrates (e.g., crayfish), several species of fish, several species of waterfowl (e.g., wood duck [*Aix sponsa*], mallard [*Anas platyrhynchos*], and ring-necked duck [*Aythya collaris*], various hooded merganser [*Lophodytes cucullatus*], and shoveler [*Anas clypeata*]) (ESE 1993), and various other birds and mammals.

2.7.4 Threatened and Endangered Plant Species

Eight federally listed (five endangered and three threatened) plant species were identified as having the potential to occur on ALAAP. These species are listed in **Table 2-4.** Mid- to late-spring surveys for these species were conducted by ESE in 1990. No listed species were found on ALAAP during these surveys.

Table 2-4. Potential Threatened and Endangered Plant Species Alabama Army Ammunition Plant, Childersburg, Alabama

Common Name	Scientific Name	Habitat
Endangered		
Harperella	Ptilimnium nodosum	Shallow permanent and intermittent ponds and seep areas in pines
Relict trillum	*Trillium reliquum*	Moist hardware forests with high organic soil content and little or no recent disturbance
Alabama leather flower	*Clematis socialis*	Bottomland hardwoods, roadside rights-of-way with silty clay soils
Green pitcher plant	*Sarracenia oreophila*	Acidic wet areas along streams
Alabama canebrake pitcher plant	*Sarracenia rubra* var. alabamensis	Sand hill seeps, swamps, and bogs
Threatened		
Little amphianthus	*Amphianthus pusillus*	Rock-rimmed pools with shallow sandy-silty soils
American hart's tongue fern	*Phyllitis scolopendrium* var. americana	Dolomitic limestone areas
Mohris Barbara's buttons	*Marshallia mohrii*	Sand clay along roadside rights-of-way, moist old field openings in woodlands

2.8 WILDLIFE

This section discusses the wildlife at ALAAP and includes information on the potential for the occurrence of T&E wildlife species at ALAAP. The section is preceded by an overview of the wildlife of central Alabama that provides a point of reference for the ALAAP-specific discussions.

2.8.1 Regional Wildlife

The wildlife of central Alabama is characteristic of the southeastern United States. Being near the transition from the southern Appalachian Mountains to the piedmont, and the associated vegetation variation of the transition, the region provides varied habitats, as discussed in Section 2.7.1, that support several plant and animal species near the limits of their natural ranges (southern limits for northern species and northern limits for southern species). The region supports abundant breeding songbird populations. Several species of game animals, such as white-tailed deer (*Odocoileus virginiana*), cotton-tail rabbit (*Sylvilagus floridanus*), and bobwhite quail (*Colinus virginiana*), are also abundant. The region is used as a migration flyway by several species of waterfowl that make use of the several large reservoirs, such as Guntersville and Weiss Lakes in northeast Alabama.

2.8.2 ALAAP Wildlife

The high degree of habitat interspersion and resulting edge habitat onsite is conducive to the presence of many game and nongame species. Edge habitat exists where two different habitat types border each other, such as a forest and an old field. Edge habitats are especially prevalent in Study Areas 6, 7, and 10, as well as along all roadways. Edge habitat can provide more life requirements, such as feeding habitat in an old field and cover habitat in a forest, in a smaller area than a single type of habitat. Wildlife that are able to exploit varied habitat, such as white-tailed deer, generally have large populations on areas with such habitat mixes. Wildlife that require larger, unbroken tracts of habitat, such as songbirds that breed deep in forest interiors, are not present at ALAAP.

Vertebrate wildlife were observed on ALAAP during onsite surveys. Several species, such as white-tailed deer, rabbit, and quail, are common in the habitat mixes of Area B. Beaver (*Castor canadensis*) have dammed some of the streams and ditches, especially the lower Crossover and Red Water Ditches, altering the habitat to meet their needs and providing habitat for other species, such as waterfowl and wading birds. Some species that were not observed but are likely to occur include both the striped (*Mephitis mehpitis*) and spotted skunk (*Spilogale putorius*), red (*Vulpes vulpes*) and grey fox (*Urocyon cinereoargenteus*), and fox squirrel (*Sciurus niger*). These species are considered likely to occur because the site is within their natural ranges and ALAAP contains suitable habitats for these species.

Several of the beaver ponds provide habitat for breeding, migrant, and wintering waterfowl. Species observed onsite at the ponds include wood duck, mallard, ring-necked duck, hooded merganser, and shoveler, with the wood duck and the mallard being the most common.

The area used by such wildlife species in its normal activities of feeding, reproducing, and rearing young is known as a home range. A home range provides all of the necessities of life (i.e., food, water, and cover) for an animal species and may be occupied by an individual, family group, or social group. Home ranges have irregular shapes and not all areas within a home range are used on a daily basis. The use of some areas within a home range may be seasonal. The

spacing of home ranges is often such that the individual or group is ensured a food supply that is not greatly encroached upon by others of the same species. Organisms are believed to have home range sizes at ALAAP that are similar to the home range sizes at other places in the southeastern United States. This precluded the need to measure the home range acreages at ALAAP. Home ranges are as small as 0.5 acres for such small mammals as shrews and as large as 1,600 acres or 2.5 mi^2 for hawks. Intermediate sizes are approximately 9 acres for rabbits and 640 acres or 1 mi^2 for deer (Ambrose et al. 1983). More details and references on assumed home range sizes are presented in Section 7.

2.8.3 Threatened and Endangered Wildlife Species

The bald eagle (*Haliaeetus leucocephalus*) and the red-cockaded woodpecker (*Picoides borealis*) are listed as endangered by the U.S. Fish and Wildlife Service. Both species have the potential to occur onsite. No onsite surveys have been conducted for the bald eagle; onsite surveys for the red-cockaded woodpecker and onsite evaluations of potential habitat have been performed (ESE 1993).

Bald eagles winter along Alabama river systems, including the Lay Lake impoundment on the Coosa River. This impoundment is created by Lay Dam, approximately 25 miles south of ALAAP. Alabama state personnel have estimated that approximately six bald eagles use portions of Lay Lake seasonally from December through February (ESE 1993). A larger wintering population uses Mitchell Lake, a water body that starts at Lay Dam and runs southward and downstream for approximately 15 miles. Although the Coosa River (and the upper reaches of Lay Lake according to the USGS Childersburg quadrangle) flows near ALAAP, the occurrence of bald eagles onsite would be expected to be transient and of a low probability. There are few nesting records for the bald eagle in Alabama.

The closest known red-cockaded woodpecker populations are in Talladega National Forest, approximately 10 to 12 miles east of ALAAP. One active colony is approximately 15 miles southeast of ALAAP, and two other active colonies were identified 20 and 21 miles east of the site. The red-cockaded woodpecker occurs in pine or mixed upland hardwood forests with open understories primarily in the piedmont and coastal plain of the southeastern United States. Onsite surveys and habitat evaluations were performed because of the proximity of these active colonies and the potential for suitable habitat to occur onsite, particularly in the pine forests at ALAAP. During field surveys there were no visual sightings of the red-cockaded woodpecker, nor was indirect evidence of its presence observed. Tree cores taken from some of the largest pines found onsite revealed ages of approximately 60 years (ESE 1993). These trees are nearing the age normally used by the red-cockaded woodpecker, but these trees occur only along drainages and not as stands at ALAAP. ESE (1993) evaluated the available habitat as marginal to unsuitable for red-cockaded woodpeckers.

3. METHODS AND PROCEDURES

The technical approach, methods, protocols, and procedures used during the field investigations that Science Applications International Corporation (SAIC) conducted at the Alabama Army Ammunition Plant (ALAAP) – Area B are described below. The techniques and procedures that were used during this study were developed using guidance from *Geotechnical Requirements for Drilling, Monitor Wells, Data Acquisition, and Reports* (USATHAMA 1987), the *Compendium of Superfund Field Operations Methods* (EPA 1987a), *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA 1988a), and *Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Branch* (EPA 1991d). Areas of conflict between these guidance documents were resolved within the Final Supplemental Remedial Investigation/Feasibility Study (RI/FS) Sampling and Analysis Plan (SAP)/Work Plan (SAIC 1995a) and the Quality Assurance Project Plan (QAPP) (SAIC 1995b), which were approved for implementation by the U.S. Army Environmental Center (USAEC), U.S. Environmental Protection Agency (EPA) Region IV, and the Alabama Department of Environmental Management (ADEM). Specific field technical procedures (FTPs) are detailed in the SAP/Work Plan (SAIC 1995a). Investigation activities outlined in the SAP/Work Plan were conducted from September 1994 through August 1995 and are referred to as the Phase 1 investigation. The majority of the Phase 1 sampling activities were implemented from March through August 1995. Three additional phases of field investigations were implemented at ALAAP – Area B. Phase 2 activities were conducted from May to July 1996 and are outlined in the Final Supplemental RI/FS SAP/Work Plan Addendum (SAIC 1996c). Phase 3 field activities were implemented from December 1996 to January 1997 and are outlined in the Final Supplemental RI/FS SAP/Work Plan Addendum 2 (SAIC 1996d). Phase 4A field activities were conducted in October and December 1997 and are outlined in the Final Work Plan Addendum for Phase 4 Investigations (SAIC 1997).

3.1 TECHNICAL APPROACH

Details regarding the overall investigation strategy for data collection are provided in Section 3.1.1. The approach for multimedia sampling and the scope, objectives, and specific sampling rationale are provided in Section 3.1.2.

3.1.1 Overall Strategy

The majority of the Area B study areas at ALAAP were investigated as source operable units with a sampling strategy that focused on identifying the vertical and horizontal extent of chemical contamination in soil and sediment in and around these areas. Because surface streams and ditches on ALAAP flow between study areas, the streams and their associated surface water and sediments were evaluated on a site-wide basis as individual study areas. Similarly, groundwater was investigated as a single unit across all of Area B. Monitoring wells were installed at strategic locations at or near the established study areas to complement existing wells while providing monitoring information between study areas. Existing data and sampling locations were used

extensively in developing the overall strategy. New monitoring well locations were established to fill data gaps identified during the initial review of the historical information and data. Phase 2 and 3 field investigation activities were developed to fill data gaps and narrow the focus of the investigation to specific study areas and data needs identified following the Phase 1 RI activities. Phase 4A field investigation activities were conducted to fill data gaps at two study areas (the Acid/Organic Manufacturing Area [Study Area 8] and the Aniline Sludge Basin [Study Area 9]).

Based on a review of the manufacturing processes (Section 1.4.2) and a review of previous studies and investigation results (Section 1.4.3), the initial focus of the Phase 1 Supplemental RI was to determine the horizontal and vertical extent of explosives and the principal detected compounds in soil and groundwater at ALAAP. Data from previous site investigations (ESE 1993) identified explosives to be reliable predictors of the occurrence of other contaminants, including other organic compounds and metals. Because of the large size of the facility (greater than 2,000 acres), surface soil and sediment samples were collected systematically and screened for explosives, lead, or polychlorinated biphenyls (PCBs) in the field in an attempt to isolate locations of elevated contaminant concentrations within the study areas.

As a result of the Phase 1 RI activities, possible source areas were identified for explosives and lead contamination that exists in the groundwater in the Smokeless Powder Facility (Study Area 2), Propellant Shipping Area (Study Area 17), Blending Tower Area (Study Area 18), Rifle Powder Finishing Area (Study Area 20), and background locations. The Flashing Ground (Study Area 16), Lead Facility (Study Area 19), and Demolition Landfill (Study Area 22) also were identified as potential source areas for existing groundwater contamination. The overall objectives of the Phase 2 and 3 RI field activities were to obtain additional data to determine the source of groundwater contamination, determine if contaminants present are discharging to the Coosa River and surface water ponds at specific site areas, and support decisions pertaining to the need for remediation and recommendations for remedial actions in these areas. The overall objectives of the Phase 4 RI field activities were to obtain data to further characterize groundwater contamination, determine if acid or organic chemicals have migrated from the Industrial Sewer System (ISS) at Study Area 8, determine the characteristics of a waste (tar-like) material at Study Area 9, and determine if remedial actions of the tar-like material were necessary. Phase 4 groundwater investigations are ongoing to further characterize the hydrogeology and contamination within Area B. This Supplemental RI addresses groundwater studies conducted during Phases 1 through 3. The results of the Phase 4 groundwater studies will be presented in a separate report.

Specifically, the Phase 2 investigation was conducted to verify the presence, chemical nature, concentration, and distribution of groundwater contaminants in Study Areas 2, 16, 17, 18, 19, 20, and background locations. Data collected during the Phase 2 field activities were used to narrow the focus for study areas to be investigated during the Phase 3 activities.

During the Phase 3 investigation, monitoring wells were installed primarily in Study Areas 17 and 18 with an additional well placed in Study Area 2 to determine potential

sources of observed groundwater contamination within the southern area of ALAAP – Area B. Wells also were installed in close proximity to Study Area 22 to fill data gaps between the background location, Area A, and Study Areas 16 and 19 and to determine if Study Area 22 was contributing to contamination detected in a shallow background well.

During the Phase 4A investigation, test pits were excavated and soil samples were collected adjacent to and beneath the base of vaults (sumps) constructed of brick and mortar located beneath manholes identified from historic maps and a survey (ESE 1992) of the ISS at Study Area 8. Test pits were excavated and soil samples were collected to determine if waste water and materials traveling through the ISS had migrated or leached from collection points (manhole vaults) along the ISS. In addition to excavating test pits in Study Area 8, samples of waste (tar-like) material and sediment underlying the waste were collected from the southern corner of Study Area 9 to determine if remedial actions are required specifically for the tar-like material.

The combination of semi-quantitative field screening for nitroaromatic compounds, lead, and PCBs combined with quantitative confirmatory laboratory analyses (volatile organic compounds [VOCs], semivolatile organic compounds [SVOCs], explosives, explosives breakdown products, and metals) formed the basis of the soil and sediment investigations conducted at ALAAP. Investigation of surface water and groundwater from Area B and locations around ALAAP was conducted by sampling and quantitative laboratory analysis.

During Phase 2, field screening and laboratory analyses were conducted on surface water samples, groundwater samples collected from constructed monitoring wells, and in situ water collected at the water table from boreholes. During Phase 3, laboratory analyses were conducted on groundwater samples collected from newly constructed and selected existing monitoring wells.

Aquatic and terrestrial biota were sampled and analyzed during Phase 1 (see Section 3.7) to assess the potential ecological impact from compounds and elements detected at the site. Surrounding media (soil, surface water, or sediment) were collected in conjunction with all biota samples so that uptake from the surrounding media could be determined. Bioassay toxicity tests were conducted during Phase 1 to evaluate the toxicity of chemicals present in the environmental media and to help develop ecological remedial goal options (ecoRGOs). During Phase 2, additional laboratory bioassay toxicity tests were conducted to refine further the ecoRGOs. Bioassays were conducted in support of the RI under the Army and regulatory guidance available at the time and with the consensus of the ALAAP stakeholders. Recent guidance recommends that bioassays be conducted during the baseline ecological risk assessment (BERA) but does not prohibit them in earlier screening-level ecological risk assessments (SERAs).

3.1.2 Sampling Approach

Field sampling conducted at ALAAP was based on the size and locations of the individual study areas, the potential media that may have been impacted by site activities, and by strategic positioning of monitoring locations around and between study areas. The approach for each

sampled medium is described below. **Tables 3-1** through **3-4** summarize the chemical analyses conducted during each phase of field activities for soil (surface and subsurface), sediment, surface water, and groundwater samples collected from each study area on ALAAP.

3.1.2.1 Chemical Field Screening

Previous investigation results indicated that surface soil sampling was biased around a limited number of historical buildings and facilities. This information was used as an indicator of the nature of the contamination, but had limited use for delineating the horizontal or vertical extent of detected compounds because of the localized nature of the sampling. The following field screening analytical techniques were used to delineate the extent of contamination during the ALAAP RI:

- A semi-quantitative analysis for nitroaromatic explosives (USACE 1990)
- Field test kits for estimating total PCB concentrations (DTECH®)
- Rapid (3 days) laboratory analysis for lead.

Test results from field screening provided systematic data over large site areas so that timely decisions could be made in the field regarding the need for additional sampling and the need to alter sample locations. The selection of the appropriate test method was based on historical data and knowledge of the former site processes.

Phase 1 Field Screening—Field screening for explosives, lead, and PCBs in surface soil, subsurface soil, and sediment was conducted during the Phase 1 activities. The lateral extent of contamination in surface soil (0 to 0.5 feet below land surface [BLS]) was delineated by sampling each study area using systematic rectangular grids with a distance between grid lines of 200 to 500 feet, depending on the size of the study area. The starting point for each grid was established using randomly derived coordinates within the study area. The remaining grid points then were fixed by a predetermined grid spacing. **Table 3-5** summarizes details of the grid spacing and the number of field screening samples analyzed from each study area during Phase 1.

After reviewing the original building locations at ALAAP, study areas were subdivided to assess potential contamination near the buildings as well as the surrounding area. The overall site area was "stratified," or divided, into subareas that were homogeneous with respect to the anticipated distribution of chemical contamination. Each subarea (stratum) was sampled using the systematic approach described above. The larger grid spacing (500 feet) was used at Study Areas 2, 8, 17, 18, and 20 based on the lack of historical buildings, non-manufacturing site usage, or the lack of historically detected compounds at these sites. The locations of field screening sampling grids for surface soils at each study area are shown on **Sheet 3-1**. All sheets are provided at the end of the volume of the report.

Table 3-1. Summary of RI Sampling and Analysis Program – Phase 1
Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area	Soil/Sediment										Surface Water/Groundwater						
	Field Screening																
	Explosives	PCB	Lead	VOCs	SVOCs	Metals	Pesticides/ PCBs	Explosives	Explosives Breakdown Products	Cr+6	VOCs	SVOCs	Metals	Pesticides/ PCBs	Explosives	Explosives Breakdown Products	Cr+6
2–Smokeless Powder Facility	✓										✓	✓	✓		✓	✓	
3–Sanitary Landfill and Lead Facility	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
4–Manhattan Project Area			✓	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	
5–Red Water Storage Basin	✓			✓	✓	✓		✓	✓	✓	✓	✓	✓		✓	✓	
6–Southern TNT Manufacturing Area				✓	✓	✓		✓	✓	✓	✓	✓	✓		✓	✓	
7–Northern TNT Manufacturing Area				✓	✓	✓		✓	✓	✓							
8–Acid/Organic Manufacturing Area	✓			✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	
9–Aniline Sludge Basin	✓			✓	✓	✓		✓	✓	✓	✓	✓	✓		✓	✓	
10–Tetryl Manufacturing Area	✓			✓	✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	
16–Flashing Ground	✓		✓	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	
17–Propellant Shipping Area	✓			✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	
18–Blending Tower Area	✓			✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	
19–Lead Facility			✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	
20–Rifle Powder Finishing Area	✓			✓	✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	
21–Red Water Ditch	✓			✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	
22–Demolition Landfill			✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓
25–Storage Battery/Demolition Debris			✓	✓	✓	✓		✓	✓	✓							
26–Crossover Ditch	✓			✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
27–Beaver Pond Drainage System	✓			✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Building 6 – Coke Oven (CERFA)	✓			✓	✓	✓		✓	✓	✓							
Transformers (CERFA)		✓				✓	✓										
USTs (CERFA)	✓				✓	✓											
Gas Station (CERFA)					✓	✓											
Fertilizer/Pesticide Storage (CERFA)	✓					✓	✓										
Talladega Creek	✓			✓	✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓
Little Blue Creek	✓			✓	✓	✓		✓	✓	✓	✓	✓	✓		✓	✓	
Coosa River	✓			✓	✓	✓		✓	✓								
Flipper Creek				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Seep				✓	✓	✓		✓	✓		✓	✓	✓		✓	✓	
Background	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table 3-2. Summary of RI Sampling and Analysis Program – Phase 2 Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area	Soil/Sediment					Water			
	Field Screening Explosives	Explosives	Lead	Metals	Al	Field Screening Explosives	Explosives	Lead	Metals
2	SB	SB	SB			HW, GW	HW, GW	HW, GW	GW
3			SS		SS	GW	GW	GW	
4			SS		SS	GW	GW	GW	
6						GW	GW	GW	
8						GW	GW	GW	
10						GW	GW	GW	
16		SB	SB, SS		SS	GW	HW, GW	HW, GW	GW
17	SB	SB	SB			HW, GW	HW, GW	HW, GW	
18	SB	SB	SB			HW, GW	HW, GW	HW, GW	
19			SS		SS				
20	SB					GW	GW	GW	
21		SD		SD					SW
22			SS		SS	GW			
26				SD					
27		SD		SD		SW	SW		SW
BK			SS	SD	SS	GW, SW	GW, SW		GW, SW
CO							SW		SW
KC							GW	GW	

Al = Aluminum
BK = Background
CO = Coosa River
GW = Groundwater
HW = Borehole Water
KC = Kimberly-Clark Corporation
SB = Soil Boring
SD = Sediment
SS = Surface Soil
SW = Surface Water

Table 3-3. Summary of RI Sampling and Analysis Program – Phase 3 Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area	Soil		Water			
	Explosives	Metals	Explosives	Lead	SVOCs	Metals
2			GW	GW		GW
3			GW	GW		GW
4			GW	GW		
6			GW	GW		
16	SD	SD	GW, SW	GW		SW
17			GW	GW		GW
18			GW	GW		GW
20			GW	GW		
22			GW		GW	GW
BK			GW	GW	GW	GW
KC			GW	GW		

BK = Background
GW = Groundwater
KC = Kimberly-Clark Corporation
SD = Sediment
SW = Surface Water

Table 3-4. Summary of RI Sampling and Analysis Program – Phase 4A Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area	Total Metals	VOCs	SVOCs	TCLP	pH
8	S		S		S
9	SD	SD, W	SD, W	W	

S = Soil sample, a soil sample was collected at the base (concrete footer) of each manhole vault (5 to 10 feet below land surface [BLS]) and a second sample was collected approximately 2 feet below the first sample (8 to 12 feet BLS).

W = Waste sample from tar-like material.

SD = Sediment sample collected beneath tar-like material.

Table 3-5. Summary of Field Screening Samples Collected in Surface Soils and Basin Sediments – Phase 1
Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area	Area (square feet)	Grid Spacing (feet)	Total Screening Samples
2 Smokeless Powder Facility	3,230,259	200/500	42
3 Sanitary Landfill and Lead Facility	327,232	200	11
4 Manhattan Project Area	140,297	200	4
5 Red Water Storage Basin	404,252	200	11
8 Acid/Organic Manufacturing Area	4,534,958	200/500	44
9 Aniline Sludge Basin	212,811	200	16
10 Tetryl Manufacturing Area	4,722,882	200	48
16 Flashing Ground	719,070	200	101
17 Propellant Shipping Area	5,485,026	500	47
18 Blending Tower Area	1,902,238	500	8
19 Lead Facility	116,281	200	17
20 Rifle Powder Finishing Area	1,842,937	500	7
22 Demolition Landfill	77,258	200	6
25 Storage Battery/Demolition Debris	103,121	200	3
27 Beaver Pond Drainage System	1,318,416	200	157
BK Background			10

Field screening of surface soil and sediment samples during Phase 1 was conducted to assess the lateral extent of explosives, PCBs, VOCs, and lead contamination. The vertical extent of these types of soil contamination was assessed by field screening subsurface soil samples. Samples from 55 soil borings were screened onsite during Phase 1. Soil boring locations were chosen by reviewing the surface soil screening results. The number of borings per study area was decided upon based on the size of the study area, historical land use, and potential for subsurface contamination. In general, soil screening samples were collected every 5 feet from the ground surface to the encountered groundwater table or to a maximum depth of 30 feet in each boring.

Field screening of sediments was conducted during Phase 1 for the presence of nitroaromatic compounds within the Red Water Ditch (Study Area 21), the Crossover Ditch (Study Area 26), the Beaver Pond Drainage System (Study Area 27), the Red Water Storage Basin (Study Area 5), and Study Area 9 using samples collected systematically along transects or on grids. Sediment samples also were systematically collected and field-screened from offsite surface water bodies, including Talladega Creek, the Coosa River, Little Blue Creek, and Fanning Creek. **Table 3-6** summarizes the grid spacing, square footage, and total number of sediment screening samples collected from each study area analyzed during Phase 1. The locations of established transects and sediment sample locations at each study area are shown on **Sheet 3-2**.

Table 3-6. Field Screening Summary for Stream Sediments – Phase 1 Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area		Area (square feet)	Grid Spacing (feet)	Total Screening Samples
21	Red Water Ditch	13,059	200/500	260
26	Crossover Ditch	36,043	200/500	401
27	Beaver Pond Drainage System	13,400	200/1,000	157
TA	Talladega Creek	41,951	200/500/5,280	102
BC	Little Blue Creek	15,840	2,640	6
CO	Coosa River			8
FC	Fanning Creek (Background)			3

Phase 2 Field Screening—During Phase 2 field activities, groundwater, borehole water, subsurface soil, surface water, and sediment samples were screened in the field for explosives and explosives breakdown products using the Jenkins Method (USACE 1990, USACE 1994). **Table 3-7** summarizes the number of samples analyzed, sample locations, and study areas evaluated during the Phase 2 activities. The primary objective of the Phase 2 screening activities was to screen groundwater collected from existing monitoring wells and boreholes and use this information to place additional soil borings and monitoring wells. Explosives screening was conducted in the field to provide real time results that could be used to expedite and modify the field investigation (i.e., change sample locations). Soil samples were collected from soil borings at the soil/water interface in conjunction with water samples from within the borehole and used to determine potential correlations between soil and groundwater explosives concentrations. Locations of soil borings from which these soil and water samples were collected are identified in **Figure 3-1**. Borehole water sample locations (i.e., HW-18-076) correspond with soil boring sample locations (i.e., SB-18-076).

Table 3-7. Summary of Field Screening Samples Collected in Surface Water, Sediment, Soil, Groundwater, and Borehole Water – Phase 2 Alabama Army Ammunition Plant, Childersburg, Alabama

Media	Number of Samples Analyzed	Analytes	Number of Sample Locations	Study Areas
Subsurface Soil	31	DNT, TNT	12 boreholes	2, 17, 18
Sediment	1	DNT, TNT	1	21
Surface Water	8	DNT, TNT	4	27, BK
Groundwater	73	DNT, TNT	48 wells	2, 3, 4, 5, 6, 8, 10, 16, 17, 18 20, 21, BK
Borehole Water	34	DNT, TNT	18 boreholes	2,17,18, BK

DNT = Dinitrotoluene
TNT = Trinitrotoluene

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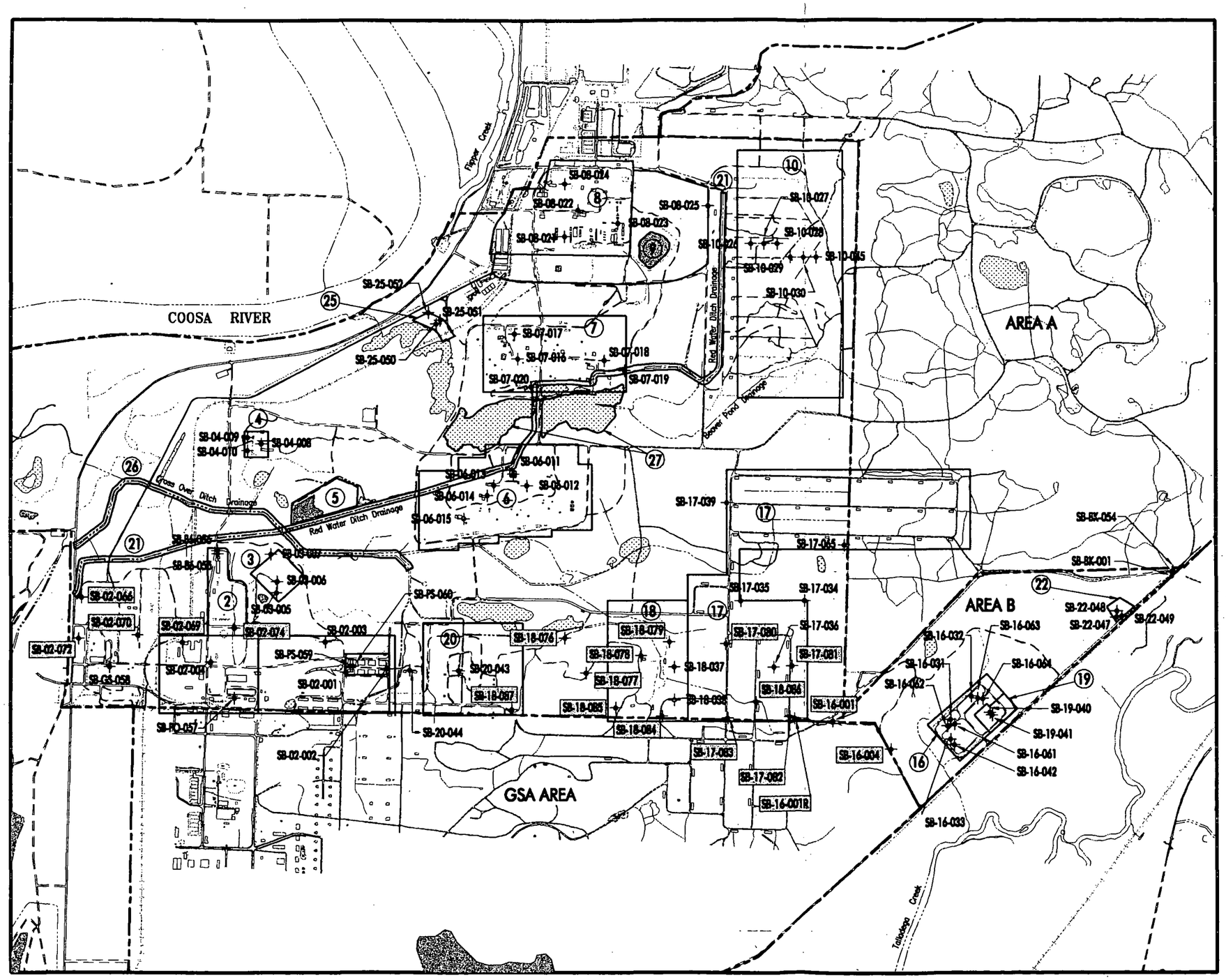


LEGEND:

- BUILDINGS
- PRIMARY ROADS
- SECONDARY ROADS
- TRAILS
- FENCE
- AREA BOUNDARIES
- 2 — STUDY AREAS
- RAIL ROAD
- CREEK, TRIBUTARIES AND RIVER
- WETLANDS
- PONDS, IMPOUNDMENTS
- SB-18-037 — PHASE I SOIL BORING LOCATION
- SB-02-001 — PHASE II SOIL BORING LOCATION

NOTES:

1. BASE MAP OF AREA B RECEIVED FROM AIR SURVEY CORP. MAP COMPILED FROM AERIAL SURVEY FEBRUARY 1995.
2. OUTSIDE AREAS OF BASE MAP RECEIVED FROM AMERICAN DIGITAL CARTOGRAPHY, SCANNED FROM USGS CHILDERSBURG 7.5 QUADRANGLE, 1984, 1" = 100,000'.

STATE PLANE GRID

0 500 1000 1500 3000

SCALE: 1" = 1500'

U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

Soil Boring
Location Map

Figure No.	Project No.	File Name	Date
3-1	01-0827-03-8178-045	99015\DWGS\E42SBOR2	03-31-99

For each soil boring, a water sample was collected from the borehole for field screening for explosives. During Phase 2, samples were screened for 2,4-dinitrotoluene (2,4-DNT) as well as 2,4,6-trinitrotoluene (TNT) if the sample extract indicated the presence of 2,4-DNT. Subsurface soil samples were collected at the borehole soil/water interface to compare soil contaminant and groundwater contaminant concentrations. **Table 3-8** summarizes the subsurface field screening analysis of borehole samples in each study area. **Table 3-9** presents borehole samples collected from each study area that were submitted for confirmatory analysis.

Four surface water and one sediment sample were collected and field screened for explosives and explosives breakdown products during the Phase 2 activities. Sampling rationale and locations are discussed in Sections 3.1.2.5 and 3.1.2.7. Sediment and surface water sample screening locations are identified on Sheets 3-2 and 3-4, respectively. The Phase 2 field screening results are summarized in Section 4. Complete Phase 2 field screening results and associated quality control (QC) data are presented in Appendix C.

3.1.2.2 Surface Soil Sampling

During the Phase 1 RI activities, samples were sent to the laboratory following field screening to confirm the chemical nature and extent of contamination within study areas at Area B. Approximately 10 percent of the total number of soil samples from each study area (or a minimum of three samples) were selected for the analysis of explosives, explosives breakdown products, VOCs, SVOCs, total metals, hexavalent chromium, and total organic carbon (TOC) (see Table 3-1). Samples submitted for laboratory analysis were selected based on the field screening results to confirm the presence or absence of explosives in the surface soil.

During Phase 2 RI activities, one surface soil sample was collected in the Sanitary Landfill and Lead Facility (Study Area 3); Manhattan Project Area (Study Area 4); Study Areas 16, 19, and 22; and background. The soil samples were not screened in the field. The samples were submitted for laboratory analysis of aluminum and lead and used to support the additional ecotoxicological bioassay studies. A summary of study areas where the soil samples were collected during Phase 2 are provided in Table 3-2. The locations of confirmatory samples are shown in **Figure 3-2**. The results of the surface soil sample laboratory analyses are provided in Section 4.

3.1.2.3 Subsurface Soil Sampling

During the Phase 1 investigation, soil boring locations (see Figure 3-1) were selected based on the field chemical screening results (i.e., explosives screening and quick-turnaround lead). Soil borings were located in areas where the surface screening results showed the highest concentrations of surface contamination. Soil samples were collected from the borings at 5-foot intervals and screened using the appropriate screening method for each study area (see Table 3-1). Each soil boring was drilled to 25 feet BLS.

Table 3-8. Soil Borings, Summary of Subsurface Field Screening Analysis – Phase 2 Alabama Army Ammunition Plant, Childersburg, Alabama

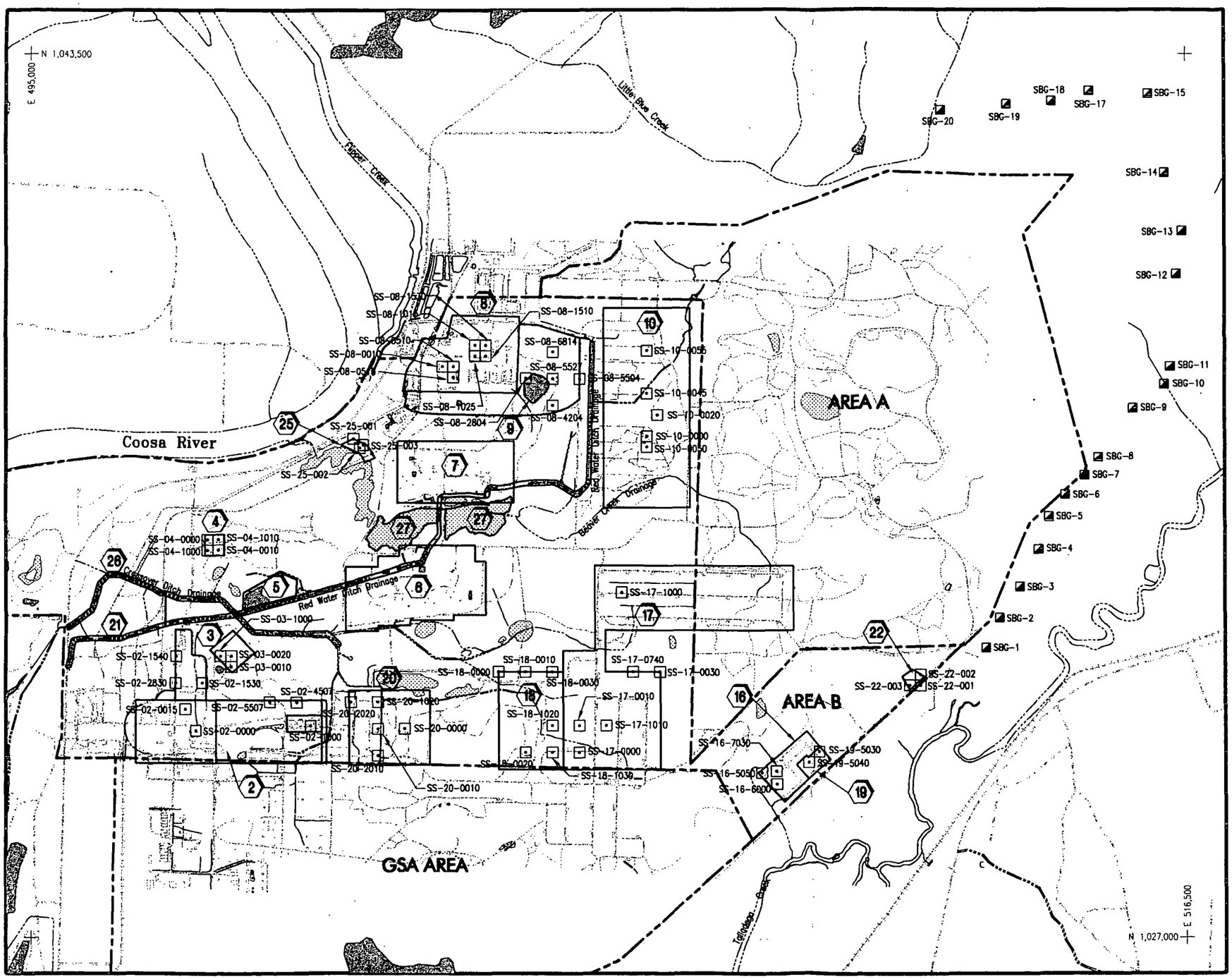
Study Area	Borehole ID	Sample Depth (feet BLS)		Analysis
		Soil	Borehole MS 3/5/99	Explosives
2	SB-02-066	1-27[a]	20.9	✓
	SB-02-069	62-64	**	✓
	SB-02-070	47-49	**	✓
	SB-02-072		25.4	✓
	SB-02-074	33-35	18.1	✓
17	SB-17-080		**	✓
	SB-17-081	43-45	55.6	✓
	SB-17-082		44.0	✓
	SB-17-083		46.1	✓
	SB-18-086	48-50	30.2	✓
18	SB-18-076	51	**	✓
	SB-18-078		**	✓
	SB-18-079		35.5	✓
	SB-18-084	48-50	49.4	✓
	SB-18-085	43-45	28.1	✓
20	SB-18-087	38-40	29.1	✓

BLS = Below Land Surface
** = Sample was screened, but sample depth was not recorded.
a = Screened from 1 to 3, 5 to 7, 10 to 12, 15 to 17, 20 to 22, and 25 to 27 feet BLS.

Table 3-9. Soil Borings, Summary of Subsurface Confirmatory Analysis – Phase 2 Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area	Borehole ID	Sample Depth (feet BLS)		Analysis	
		Soil	Borehole Water	Explosives	Lead
2	SB-02-003		24.5	✓	✓
	SB-02-066	26	20.9	✓	✓
16	SB-16-001	49	**	✓	✓
	SB-16-002	*	32.6	✓	✓
	SB-16-003	33	**	✓	✓
	SB-16-005	*	82.4	✓	✓
	SB-16-006	64	41.4	✓	✓
	SB-16-007	57	40.9	✓	✓
17	SB-17-080		45.0	✓	✓
	SB-17-083	44	50.0	✓	✓
18	SB-18-076	51	51.0	✓	✓
	SB-18-077	53	52.0	✓	✓
	SB-18-078	43	52.0	✓	✓

BLS = Below Land Surface
* = Soil samples were not collected at this location.
** = Borehole water samples were not collected if groundwater was absent from the borehole.



LEGEND:

- BUILDINGS
- PRIMARY ROADS
- SECONDARY ROADS
- TRAILS
- FENCE
- AREA BOUNDARIES
- 7 STUDY AREAS
- RAIL ROAD
- CREEK, TRIBUTARIES AND RIVER
- WETLANDS
- PONDS, IMPOUNDMENTS
- SS-20-0000 CONFIRMATION SURFACE SOIL SAMPLE LOCATION
- SBG-1 ESE SURFACE SOIL BACKGROUND SAMPLE LOCATIONS
- GRID BASED ON ALABAMA STATE PLANE EAST

NOTES:

1. BASE MAP OF AREA B RECEIVED FROM AIR SURVEY CORPORATION. MAP COMPILED FROM AERIAL SURVEY, FEBRUARY 1995.
2. OUTSIDE AREAS OF BASE MAP RECEIVED FROM AMERICAN DIGITAL CARTOGRAPHY, SCANNED FROM USGS CHILDERSBURG 7.5 MIN. QUADRANGEL DATED 1984, 1" = 100,000'.
3. ESE SURFACE SOIL BACKGROUND SAMPLE LOCATIONS RECEIVED FROM AEC PYRAMID SYSTEM, NOVEMBER 1995. ACCURACY EQUALS M1 (READ FROM A MAP WITHIN 10 METERS).

STATE PLANE GRID

0 1000 2000 4000

SCALE: 1" = 2000'

U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

Confirmation Surface Soil Sample Location Map

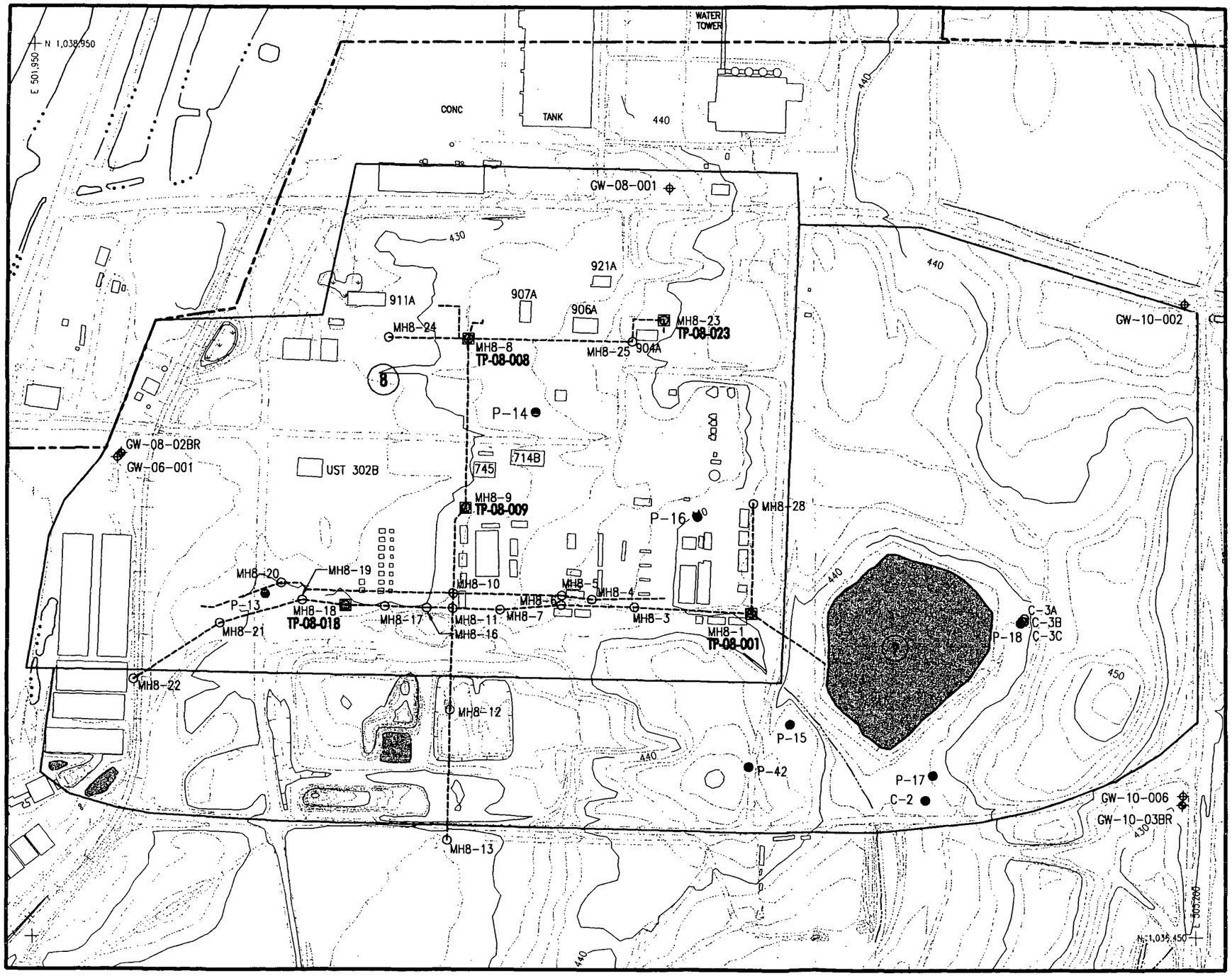
Figure No.	Project No.	File Name	Date
3-2	01-0827-03-8178-045	99015\DWGS\E42SSCON	03-31-99

Soil borings drilled during Phase 2 activities were drilled to the water table in Study Areas 2, 16, 17, 18, and 20. A soil sample was collected from the boreholes just above the water table and a groundwater sample was collected in the upper portion of the water table. In some instances, neither a soil nor water sample could be obtained because the water table was not encountered prior to encountering bedrock or auger refusal. Samples were screened at the onsite laboratory for explosives. If explosives were detected using the field screening method, the sample was sent to the laboratory for analysis of explosives and explosives breakdown products. The screening and laboratory data were intended to delineate the presence of contamination in or just above the water table. Study areas where soil borings were drilled during the Phase 2 investigation are provided in Table 3-9 along with the chemical analyses requested. The soil boring locations are shown in Figure 3-2.

3.1.2.4 Test Pit Soil Sampling

During the Phase 4A investigation, five test pits were excavated at the Study Area 8 ISS manholes. Test pits also had been excavated alongside selected ISS manholes during the FS conducted in 1992 by Environmental Science and Engineering (ESE); however, compounds that were expected to be detected within the ISS based on the past production activities (e.g., acids and organics) were not scoped for analysis in the FS (ESE 1992). Test pits were excavated at five ISS manhole locations to determine if organic or metal contamination has migrated from structures beneath manholes and into the surrounding soils as a result of past waste disposal activities at the site. The manhole vaults (sumps) at each manhole location were constructed of mortar and brick and the manhole vaults were constructed on a concrete footer. The locations of the test pits were identified based on the ISS FS results (e.g., condition of the located manholes and soil pH) and the depth of the manhole. Vaulted areas located beneath manholes were selected with total depths no greater than approximately 10 feet BLS to ensure that the data would be incorporated into the human health risk assessment. A secondary objective in choosing the test pit locations was to fully characterize the Study Area 8 ISS by locating test pits at manhole locations along both the main ISS line that discharged liquid wastes into the Red Water Ditch and the main ISS line that discharged liquid wastes into the Coosa River via manmade open ditches, including locations at significant junctions within the system (where feeder lines join either one of the two main ISS lines). The following test pits were excavated: MH-8-1, MH-8-8, MH-8-9, MH-8-18, and MH-8-23. The test pit locations are provided in **Figure 3-3.**

During the Phase 4A RI, test pits were excavated as close as possible to each of the five selected manholes. Two samples were collected from each test pit. Samples were collected in soils that exhibited soil discoloration or staining. One soil sample was collected at a depth comparable to the base (5 to10 feet) of the floor and the second soil sample was collected at a depth approximately 2 feet below the bottom (8 to 12 feet) of the concrete footer. The 10 soil samples collected from the test pit excavations were sent to the laboratory and analyzed for soil pH, total metals, and SVOCs.



LEGEND:

- BUILDINGS
- PRIMARY ROADS
- SECONDARY ROADS
- TRAILS
- FENCE
- RAILROAD
- AREA BOUNDARY
- STUDY AREAS
- RIVER, CREEK AND TRIBUTARIES
- PONDS OR IMPOUNDMENTS
- P-22 ESE MONITORING WELL (SHALLOW)
- P-54 ESE MONITORING WELL (BEDROCK)
- GW-17-007 SAIC MONITORING WELL (SHALLOW)
- GW-17-09BR SAIC MONITORING WELL (BEDROCK)
- MH8-10 MANHOLE LOCATION
- TP-08-008 SOIL SAMPLES FROM TEST PITS
- INDUSTRIAL SEWER LINE

NOTES:

1. BASE MAP OF AREA B RECEIVED FROM AIR SURVEY CORPORATION. MAP COMPILED FROM AERIAL SURVEY FEBRUARY, 1995.
2. OUTSIDE AREAS OF BASE MAP RECEIVED FROM AMERICAN DIGITAL CARTOGRAPHY, SCANNED FROM USGS CHILDERSBURG 7.5 QUADRANGLE DATED 1984, 1" = 100,000'.
3. MONITORING WELL LOCATIONS FROM SAIC VALIDATED DATA BASE SEPTEMBER, 1995.
4. ESE SURFACE SOIL BACKGROUND SAMPLE LOCATION ACCURACY EQUALS M1; READ FROM A MAP WITHIN 10 METERS.

STATE PLANE GRID

0 100 200 300 600

SCALE: 1" = 300'

U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

Test Pit Locations at Study Area 8

Figure No.	Project No.	File Name	Date
3-3	01-0827-03-8178-045	99015/DWGS/E42-PIT	03-31-99

3.1.2.5 Sediment Sampling

Based on the results of a previous risk assessment conducted at Area B (ESE 1993), preliminary remediation goals (PRGs) for TNT (647 and 34.3 μg/g) and lead (250 and 200 μg/g) were established for industrial and residential site usage, respectively. These PRGs were approved in the Interim Record of Decision for Study Areas 6, 7, 10, and 21 (Weston 1994d) and were the most current available when the Phase 1 field investigation was conducted. Sediment samples were collected during Phase 1 activities along transects perpendicular to the surface water drainages and site ditches, including the Beaver Pond drainages, Talladega Creek and tributaries, Little Blue Creek, and the Coosa River. Transects were established at 200- or 500-foot intervals along the onsite ditches and drainages, depending on the location and length of the stream. The transect interval and sample information is provided in Table 3-6. Five samples (A through E) were collected along each transect for field screening analyses. For every tenth transect within each investigated surface water drainage, sediment samples were collected for confirmatory laboratory analyses, including VOCs, SVOCs, explosives, explosives breakdown products, and metals analyses. Sediment samples that were collected from offsite streams and the Coosa River were collected at larger intervals, as indicated in Table 3-6. The locations of the confirmatory sediment samples are shown on **Sheet 3-3**.

Sediment samples were collected during the Phase 2 investigation to fill data gaps identified as a result of the Phase 1 RI. One sediment sample was collected from Study Area 21 at the location where the Red Water Ditch exits the Area B property to determine the potential for explosives migration from this study area. Sediment samples were collected from the swamps and wetlands north of Study Area 18 to determine if contaminants present in the groundwater are migrating to surface water bodies. Finally, sediment samples were collected from Study Areas 21, 26, 27, and Fanning Creek to support the additional ecotoxicological bioassay studies. Table 3-2 summarizes the study areas where sediment samples were collected during Phase 2 and the chemical analyses requested for each sample. The sediment sample locations are shown on Sheet 3-3.

During the Phase 4A investigation, sediment samples were collected from four locations within Study Area 9. At two of the locations (SD-09-001 and SD-09-002), samples were collected in the sediment directly under locations where samples of the tar-like waste were collected (TAR-09-001 and TAR-09-002). Samples were collected at the remaining two locations (SD-09-003 and SD-09-004) from sediment beneath the outer extremes of the tar-like waste to provide an overall distribution of chemical constituents potentially leaching into the sediment underlying the waste material. The sediment sample locations are shown on Sheet 3-3. The samples were analyzed at the laboratory for VOCs, SVOCs, and metals.

3.1.2.6 Tar Sampling

A waste (tar-like) material exists at the surface in the southern section of Study Area 9. The origin and time of disposition of the waste material is unknown; however, from visual inspection of

the tar-like substance, it is thought that the material is not associated with the documented use of the basin.

During the Phase 4A investigation, waste (tar-like) samples were collected in the center of the solidified waste area just below the hardened, weathered surface of the material (approximately 0.5 feet BLS) at two locations in Study Area 9. The locations of the tar samples are shown on Sheet 3-3. The samples were collected and analyzed at a laboratory for metals, VOCs, SVOCs, pesticides, cyanide, and toxicity characteristics leaching procedure (TCLP) to establish if the waste was a Resource Conservation and Recovery Act (RCRA) hazardous or nonhazardous waste.

3.1.2.7 Surface Water Sampling

Surface water sample locations were selected during the Phase 1 activities to characterize water quality in each standing water body and drainage in Area B and from surface water drainages surrounding ALAAP (Coosa River, Talladega Creek, and Little Blue Creek). The surface water sample locations are shown on **Sheet 3-4**. Instantaneous flow measurements were not made at the sampling locations because of the low flow conditions in the streams. Filtered and unfiltered samples from four locations were analyzed for the parameters listed in Table 3-1.

During Phases 2 and 3 of the RI, additional surface water samples were collected to fill data gaps identified as a result of the Phase 1 investigation. Samples were collected from the Coosa River at approximate locations corresponding to sediment sample locations established during the Phase 1 investigation. These samples were collected to determine if contaminants present in the groundwater are migrating and discharging to the Coosa River. Surface water samples were collected from swamps and wetlands north of Study Area 18 (at locations corresponding to the sediment samples) to determine if contaminants present in the groundwater are migrating to the surface water bodies. Finally, surface water samples were collected from Study Areas 16, 21, 27, a groundwater seep, and Fanning Creek to support the additional ecotoxicological bioassay studies. The study areas where surface water samples were collected during Phases 2 and 3 are shown in Tables 3-2 and 3-3 along with the chemical analyses requested. The surface water samples from the swamps and the groundwater seep were field screened for explosives and are shown in Table 3-7. The locations where surface water samples were collected are shown on Sheet 3-4.

3.1.2.8 Groundwater Sampling

Prior to initiating the installation of groundwater monitoring wells during the Phase 1 investigation, groundwater samples were collected from 48 existing wells that were located within an area of historically detected inorganic and organic chemical compounds. The sampling was conducted to obtain time-coincident, full parameter (VOCs, SVOCs, explosives, explosives breakdown products, metals) chemical analyses from the area and to fill a data gap in the historical data. Based on the results of the initial groundwater sampling round, the locations of existing monitoring wells, and the locations of potential contaminant source areas, 40 additional monitoring

wells (see **Sheet 3-5**) were located and installed during Phase 1 (see **Table 3-10**). The monitoring wells were strategically located with respect to the existing well network and provided both study area specific and general ALAAP groundwater monitoring coverage. Subsequently, the 40 new wells and 50 existing wells were sampled for explosives, explosives breakdown products, VOCs, SVOCs, total and dissolved metals, pH, and specific conductance to characterize groundwater chemistry over all of Area B. Dissolved metals were analyzed for selected groundwater samples.

Twenty-one additional wells were installed during the field activities conducted during Phases 2 and 3. Table 3-10 shows the monitoring wells installed during Phases 2 and 3. Groundwater samples were collected during each phase to determine further the source of groundwater contamination identified in Phase 1, fill in data gaps in the southern area of ALAAP – Area B, and provide a second round of groundwater results for the 40 new wells installed during Phase 1. Preceding each phase of field activities, groundwater sample locations were selected based on analytical results obtained from groundwater sampling, elevated contaminant concentrations in existing wells, and wells in strategic locations. Groundwater samples from wells were field screened for explosives and analyzed at the laboratory during the Phase 2 sampling event. Groundwater samples collected from newly installed monitoring wells during Phases 2 and 3 were analyzed for metals, explosives, and explosives breakdown products. All other groundwater samples collected during Phases 2 and 3 were analyzed for lead, explosives, and explosives breakdown products. Lead was selected as the metal for analysis because previous sampling indicated that lead contamination of the groundwater was pervasive in comparison to all other metals.

3.1.2.9 Exploratory Investigation

Several potential areas of concern were identified in the Community Environmental Response Facilitation Act (CERFA) report (TETC 1994) and from discussions with USAEC and the facility caretaker. Because little or no information existed for these CERFA sites, biased exploratory sampling was conducted to assess the potential presence of soil contamination or buried tanks on the sites. Sampling points were located based on stains or proximity to site features (i.e., drums, poles, and buildings) and field screening for PCBs was completed on the soil samples at sites with suspected PCB contamination. Surface soil confirmatory samples were collected from each area and at least one soil boring was drilled in each area. Laboratory analyses conducted on samples obtained from the CERFA sites are summarized in Table 3-1. The locations of the CERFA-related sampling points are shown on **Sheet 3-6**.

Two underground storage tank (UST) locations and a former gas station were identified in the CERFA report (TETC 1994) and an additional UST location was identified by the ALAAP caretaker. Each site had been the subject of a previous removal action. Geophysical surveys were conducted at the four locations prior to chemical screening or sampling to investigate the presence of USTs and assist in the placement of soil borings. The locations of geophysical surveying associated with the CERFA sites are shown in **Figure 3-4**.

Table 3-10. Well Installation Data – SAIC Wells
Alabama Army Ammunition Plant, Childersburg, Alabama

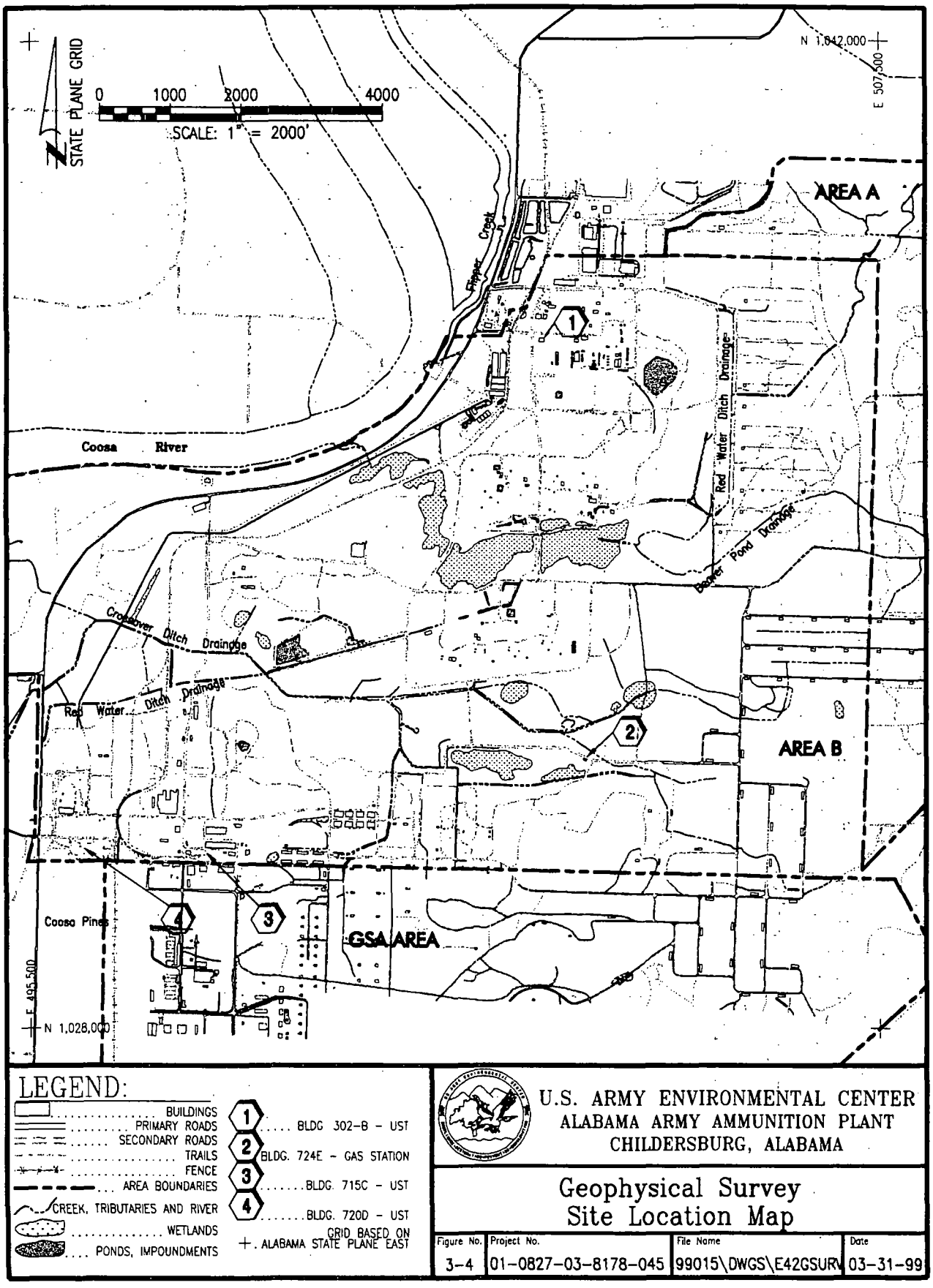
Well #	Phase Installed	Study Area	Elevation (msl) Top of Casing (TOC)	Screened Interval (BLS)	Sand Pack Interval (BLS)	Total Depth (BTOC)
GW-BK-001	1	background	437.06	40.3 - 30.3	23.8 - 43.0	43.1
GW-BK-02BR	1	background	437.66	75.0-65.0	NA	77.7
GW-02-001	1	2	433.59	35.6 - 25.6	37.8 - 18.1	38.4
GW-02-002	1	2	449.36	44.0-34.0	47.0-28.9	47.0
GW-02-003*	2	2	424.63	32.35-22.60	32.8-17.9	35.4
GW-02-005*	3	2	438.54	61.1-51.1	63.0-45.5	64.0
GW-03-001	1	3	423.65	27.5 - 17.5	31.7 - 12.5	30.3
GW-03-002	1	3	449.50	70.7 - 60.7	71.7 - 51.8	73.5
GW-03-003	1	3	454.96	58.8 - 48.8	60.0 - 39.9	61.6
GW-03-004	1	3	420.74	21.1 - 11.1	23.5 - 6.1	23.9
GW-03-005*	3	3	421.16	20.8-10.8	22.0-8.0	23.7
GW-04-001	1	2	427.54	25.1 - 15.1	25.6 - 10.0	27.9
GW-04-02BR	1	4	420.95	63.8-43.8	67.10-37.5	66.5
GW-04-003	1	4	418.68	42.0 - 32.0	43.6 -26.6	44.8
GW-04-004	1	4	418.68	29.6 - 19.6	31.0 - 15.0	32.4
GW-05-001	1	4	421.67	27.4 - 17.4	28.5 - 10.0	30.3
GW-06-001	1	8	427.60	28.8 - 18.8	30.0 - 14.2	31.6
GW-06-002	1	6	426.23	16.7 - 6.7	18.0 - 4.6	19.5
GW-08-001	1	8	437.58	41.6 - 31.6	42.5 - 25.5	43.4
GW-08-02BR	1	8	427.92	105.7-75.7	NA	108.6
GW-10-001	1	10	434.92	31.1 - 21.1	32.0 - 11.0	33.7
GW-10-002	1	10	436.99	55.9-45.9	57.2-36.5	58.7
GW-10-03BR	1	10	432.88	62.4-42.4	63.5-36.1	65.3
GW-10-004	1	10	425.92	45.0-35.0	46.9-27.2	47.8
GW-10-005	1	10	435.71	36.4-26.4	37.2-19.2	39.2
GW-10-006	1	10	433.19	25.2 - 15.2	28.0 - 9.2	28.0
GW-16-002*	2	16	470.52	34.95-25.20	37.6-19.20	38.1
GW-16-003*	2	16	458.25	44.55-34.81	45.3-27.3	47.4
GW-16-005*	2	16	495.04	86.78-77.03	86.0-71.2	90.0
GW-16-006*	2	16	447.65	61.96-52.21	63.0-46.8	65.2
GW-16-007*	2	16	457.63	55.68-45.93	57.0-38.3	59.1

* Pre-pack Well Screen
BLS = Below Land Surface
TOC = Top of Casing
BTOC = Below Top of Casing
msl = Mean Sea Level

Table 3-10. Well Installation Data – SAIC Wells Alabama Army Ammunition Plant, Childersburg, Alabama (Continued)

Well #	Phase Installed	Study Area	Elevation (msl) Top of Casing (TOC)	Screened Interval (BLS)	Sand Pack Interval (BLS)	Total Depth (BTOC)
GW-17-001	1	17	466.04	36.9-26.9	37.5-21.5	39.4
GW-17-002	1	17	469.42	40.1-30.1	41.5-24.0	43.1
GW-17-003	1	17	458.66	29.0 -19.0	35.0 - 16.5	34.8
GW-17-004	1	17	463.33	54.2-44.2	55.5-37.8	57.0
GW-17-005	1	17	498.62	45.9-35.9	49.0-30.8	48.3
GW-17-006	1	17	460.02	35.9-25.9	38.0-19.3	38.7
GW-17-007	1	17	499.49	41.1 - 31.1	42.0 - 26.0	43.7
GW-17-09BR	1	17	466.72	119.6-99.6	NA	122.6
GW-17-10BR	1	17	497.10	139.6-119.6	140.0-113.0	142.3
GW-17-011*	3	17	465.68	54.14-44.30	56.00-32.80	57.0
GW-17-012*	3	17	455.28	82.1-72.35	83.0-67.0	85.0
GW-17-013*	3	17	491.38	88.30-78.48	91.0-68.10	91.2
GW-17-014*	3	17	535.01	122.48-112.65	124.0-91.60	125.4
GW-17-015*	3	17	470.20	64.6-54.85	66.0-44.8	67.5
GW-17-016*	3	17	488.10	79.35-69.35	81.0-57.2	82.3
GW-17-018*	3	17	431.98	50.6-40.6	53.0-36.8	53.5
GW-17-019*	3	17	456.10	62.1-52.35	63.8-47.0	65.0
GW-18-001	1	18	442.49	41.7-31.7	43.5-24.1	44.5
GW-18-002	1	18	428.30	25.0-15.0	26.5-10.6	26.8
GW-18-003	1	20	432.86	45.8-35.8	47.3-29.6	48.6
GW-18-005*	3	18	472.22	78.4-68.4	80-63.7	81.3
GW-18-006*	3	20	438.18	53.6-43.85	56.0-34.0	56.5
GW-18-007*	3	20	424.91	21.6-11.6	23.0-9.2	24.5
GW-20-01BR	1	20	436.81	71.2-51.2	71.6-45.2	74.1
GW-20-002	1	20	424.04	19.4 - 9.4	20.7 - 5.8	22.2
GW-20-03BR	1	20	423.44	56.0-36.0	59.0-31.0	58.9
GW-21-01BR	1	2	427.40	62.6-42.6	63.0-37.0	65.3
GW-21-02BR	1	2	433.54	86.0-66.0	90.0-59.0	88.8
GW-22-001*	3	22	453.88	53.3-43.55	54.2-38.5	56.2
GW-22-002*	3	22	451.85	40.6-30.85	41.5-25.85	43.5

* Pre-pack Well Screen
BLS = Below Land Surface
TOC = Top of Casing
BTOC = Below Top of Casing
msl = Mean Sea Level


STATE PLANE GRID
0 1000 2000 4000
SCALE: 1" = 2000'
N 1,042,000
E 507,500
AREA A
Pinger Creek
Coosa River
Red Water Ditch Drainage
Beaver Pond Drainage
Crawfish Ditch Drainage
Red Water Ditch Drainage
AREA B
Coosa Pines
GSA AREA
E 495,500
N 1,028,000
LEGEND:
BUILDINGS
PRIMARY ROADS
SECONDARY ROADS
TRAILS
FENCE
AREA BOUNDARIES
CREEK, TRIBUTARIES AND RIVER
WETLANDS
PONDS, IMPOUNDMENTS
1 BLDG. 302-B - UST
2 BLDG. 724E - GAS STATION
3 BLDG. 715C - UST
4 BLDG. 720D - UST
GRID BASED ON ALABAMA STATE PLANE EAST
U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA
Geophysical Survey
Site Location Map
Figure No. 3-4
Project No. 01-0827-03-8178-045
File Name 99015\DWGS\E42GSURV
Date 03-31-99

3.2 WELL INVENTORY

As part of the Phase 1 field activities at ALAAP, an inventory of the existing monitoring well network in both Areas A and B on ALAAP was completed to assess the condition and confirm the presence of the wells previously installed on the facility. The well inventory was conducted in September 1994 by a five-man field crew assisted by the ALAAP site caretaker. A total of 89 well locations were identified with 3 wells (i.e., P-23, P-24, and P-76) observed to be either destroyed or abandoned. Twenty additional wells could not be located either because they were improperly located, had been destroyed, or were concealed by dense vegetation. The 1994 well inventory results are provided in **Table 3-11** and inventory sheets for each well are provided in Appendix A.

3.3 AERIAL MAPPING AND TOPOGRAPHIC SURVEYING

Aerial surveying was conducted over ALAAP – Area B as part of Phase 1 of the Supplemental RI to accurately locate and map site features, including roads, trails, streams, ponds, and building structures using the Alabama (east) State Planar Coordinate System (ASPCS). An additional objective of the aerial survey was to produce a detailed topographic map of Area B and portions of the Alliance Coosa Pines (formerly Kimberly-Clark) facility bordering the southern property boundary of Area B. Land surveying was completed at the site to provide ground control for the aerial survey, re-survey existing monitoring wells (using the ASPCS) that were previously surveyed in the local ALAAP coordinate system, verify the elevations of previously surveyed wells, and locate and obtain top of casing elevations for all newly installed monitoring wells and staff gauges.

3.3.1 Aerial Survey

The aerial survey of Area B was completed to map ground topography and site features and to obtain an accurate and current representation of the installation. Aerial photography was obtained at an average height of 3,600 feet above the mean terrain surface. The site was flown in an east/west direction along three flight lines with photographic coverage consisting of 23 black and white overlapping exposures obtained with 60 percent forward overlap and 30 percent lateral overlap to ensure complete coverage of the installation. The aerial survey was completed in February 1995 under conditions of reduced shadowing and a time of year when vegetation on ALAAP was minimal.

Using the rectified photographic coverage, a topographic map was produced using 13 existing groundwater monitoring well locations and 7 surveyed benchmark locations as ground control. The map was produced conforming to National Map Accuracy Standards for a map scale of 1 inch = 400 feet with 2-foot contour intervals. Features were mapped to a horizontal accuracy of 0.025 inches and a vertical accuracy of 1 foot with spot elevations within 0.5 feet. Aerial surveying, photogrammetry, and mapping of Area B was completed by Air Survey Corporation of Sterling, Virginia.

Table 3-11. Well Inventory – September 1994
Alabama Army Ammunition Plant, Childersburg, Alabama

Well	Depth to Water (9/94)	Measured Depth (BTOC)	As Built Depth	Lock	Label	Protective Casing (diam)	Bumper Posts (#)	Surface Pad	TOC Stickup (feet)	Well Cap Type	Visible Damage	Piezometer or Bailer in Well	Comments Observations
D-1	**Well Not Located**												
D-2	25.45	74.65	72.90	*					0.95	VL	*	piez	Well casing broken off at surface
D-3	21.61	65.35	64.60						0.88	V		piez	Black silt on bottom
D-4	11.68	80.51	114.80					*	1.23	V			Brown-gray silt on bottom
D-5	**Well Not Located**												
D-6	8.79	NR	45.70						0.50	V		piez	Piezometer rises above well casing, cap 2 feet long
D-7	**Well Not Located**												
D-7B	18.12	130.26	130.00	*	*	0.70	2		1.91	V			
D-8	**Well Not Located**												
D-9	15.20	58.37	56.00	*	*	0.70	4	Gravel	1.79	V			
D-10	34.40	85.70	83.50	*	*	0.70	*	Gravel	1.58	V			Soft bottom
D-11	25.32	103.10	98.30	*	*	0.70	4	Gravel	2.42	V			
D-12	26.30	105.60	103.00	*	*	0.73	4	Gravel	2.50	V			
D-13	27.52	101.71	99.50	*	*	0.70	4	Gravel	2.17	V			
D-14	46.44	106.50	93.50	*		0.75	3	Gravel	2.25	V			Soft bottom
D-15	**Well Not Located**												
D-16	62.23	190.40	188.50	*	*	0.75	*	Gravel	2.20	V			Cap froze, screw off top 0.3 feet of well casing
D-17	~109	199.50	188.80	*	*	0.75	4	Gravel	2.00	V			
D-18	59.58	140.40	130.00	*	*	0.75	4	Gravel	2.25	V			Firm bottom
D-19	79.97	151.75	148.60		*	0.75	4	Gravel	2.00	V	*		Ants all over well casing and inside well
D-20	>100	~112	NR	*	*	0.75	3	Gravel	~2.45	V			Plumb weight lost in well
C-1A	**Well Not Located**												
C-1B	**Well Not Located**												
C-1C	**Well Not Located**												
C-2	19.60	47.44	68.00										
C-3A	22.05	48.99	46.40										
C-3B	19.70	27.91	25.00										
C-3C	20.08	37.91	35.00										
"D"	30.14	41.95		*				*	2.01	VL			
"F"	12.88	17.13					1	*	2.12	V			2-inch diameter PVC
"G"	10.17	36.16					1	*	2.17	V			2-inch diameter PVC

V = Vented
VL = Vented Locking
ES = Expandable Seal

Table 3-11. Well Inventory – September 1994
Alabama Army Ammunition Plant, Childersburg, Alabama (Continued)

Well	Depth to Water (9/94)	Measured Depth (BTOC)	As Built Depth	Lock	Label	Protective Casing (diam)	Bumper Posts (#)	Surface Pad	TOC Stickup (feet)	Well Cap Type	Visible Damage	Piezometer or Bailer in Well	Comments Observations
"H"	12.48	51.31					1	*	1.00	V			2-inch diameter PVC
"I"	12.52	24.91					1	*	2.00	V			Soft, gray silt on bottom
P-1	**Well Not Located**												
P-2	**Well Not Located**												
P-3	**Well Not Located**												
P-4	18.60	32.50	31.50						3.60	V	*		Casing burnt & bent, marked in field as "A"
P-5	24.55	31.30	30.00	*					2.40	VL			Marked in field as "C"
P-6	**Well Not Located**												
P-7	17.75	26.40	26.50						~2.13	V			Marked in field as "B"
P-8	16.24	24.48	21.50	*					~2.18	VL			Ant hill against casing
P-9	**Well Not Located**												
P-10	15.28	33.10	30.00	*				*	3.05	VL			Concrete pad heaving 0.3 feet; gray silt on bottom
P-11	14.63	20.09	17.00	*					2.45	VL			Spider web inside casing
P-12	22.62	38.09	35.00	*					3.09	VL			Marked in field as 18
P-13	23.74	31.37	30.00						2.26	V			Silt and moss on bottom
P-14	26.12	39.82	37.50					*	2.84	V		6' bailer	
P-15	31.04	32.75	31.50	*				*	2.55	V		5' bailer	
P-16	**Well Not Located**												
P-17	22.74	37.60	36.50						NR	V		5' bailer	Red clay on bottom
P-18	19.92	22.78	21.50				1	*	3.16	V			Obstructed
P-19	**Well Not Located**												
P-20	**Well Not Located**												
P-21	30.59	Feb-00	34.90	*		0.75	*	Gravel	~2.45	ES			
P-22	9.96	Jan-00	26.50						NR	V	*		Crack in well casing 1 foot above ground surface, jagged TOC
P-23	**Well Destroyed**												**Well was approx. 50 feet west of P-72**
P-24	**Well Destroyed**												**Well was approx. 50 feet east of P-54**
P-25	38.73	39.10	43.00						2.50	V		5' bailer	Sediment on bottom

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Table 3-11. Well Inventory – September 1994
Alabama Army Ammunition Plant, Childersburg, Alabama (Continued)

Well	Depth to Water (9/94)	Measured Depth (BTOC)	As Built Depth	Lock	Label	Protective Casing (diam)	Bumper Posts (#)	Surface Pad	TOC Stickup (feet)	Well Cap Type	Visible Damage	Piezometer or Bailer in Well	Comments Observations
P-26	47.98	52.42	51.50						2.20	V			Jagged TOC lip
P-27	24.66	25.20	22.00						3.00	V			
P-28	28.80	29.10	27.00						NR	V	*	5' bailer	Burn marks on back side, jagged TOC lip
P-29	9.77	10.05	7.50						2.00	V		5' bailer	
P-30	23.52	23.83	21.50	*					3.40	V	*		Burn marks along well base
P-31	16.58	29.12		*			1	*	2.26	VL			Marked in field as "J"; brown clay on bottom
P-32	18.86	25.80	24:50	*			1	*	1.00	VL		piez	
P-35	13.02	43.76	42.50	*			1	*	0.67	VL			Light brown clay on bottom
P-36	15.55	32.15	31.50				1	*	2.50	V			
P-37	14.18	23.90	28.00	*			1	*	3.04	VL			Brown gray silt on bottom
P-39	**Well Not Located**												
P-41	14.90	22.23	20.50					*	1.21	V			Concrete heaved 0.4 feet
P-42	36.04	37.71	35.50	*			1	*	2.92	VL			Brown gray gel on bottom
P-44	19.18	50.66	51.00	*			1		2.29	VL			Portion of old broken pad near well; silt on bottom
P-46	**Well Not Located**												
P-48	7.62	7.76	4.60						NR	V		5' bailer	
P-49	**Well Not Located**												
P-50	12.06	32.16	33.60	*					1.54	VL			Light gray silt on bottom
P-51	14.80	30.75	33.50	*					1.60	VL		piez	
P-52	19.24	36.32	49.50	*	*				1.60	VL			Clay and weeds on bottom
P-53	**Well Not Located**												
P-54	69.73	84.36	83.20		*	0.75		Gravel	~2.45	V			
P-55	63.97	84.30	83.60		*	0.75			~2.45	V			Cut in vent cap; soft bottom
P-56	67.23	75.51	73.30		*	□			~2.45	V	*		Burn marks, cap froze, screw off top 0.3 feet of casing
P-57	67.23	75.30	72.80		*	0.75		Gravel	~2.45	V			Cap froze, screw off top 0.3 feet of casing; soft bottom

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Table 3-11. Well Inventory – September 1994
Alabama Army Ammunition Plant, Childersburg, Alabama (Continued)

Well	Depth to Water (9/94)	Measured Depth (BTOC)	As Built Depth	Lock	Label	Protective Casing (diam)	Bumper Posts (#)	Surface Pad	TOC Stickup (feet)	Well Cap Type	Visible Damage	Piezometer or Bailer in Well	Comments Observations
P-58	67.23	100.49	97.50		*	0.75		Gravel	~2.45	V			Cap froze, screw off top 0.3 feet of casing; soft bottom
P-59	92.76	104.70	105.00		*	0.75		Gravel	~2.45	V			Cap froze, screw off top 0.3 feet of casing; soft bottom
P-60	10.80	31.20	28.30	*	*	0.50		Gravel	2.30	V			Debris visible on water
P-61	25.05	45.92	43.50	*	*	0.70			1.75	V			Top 1 foot of casing is loose—needs correct threading
P-62	31.95	40.85	38.60	*	*	0.70	4	Gravel	1.80	V			
P-63	23.52	36.61	35.80	*	*	0.70	4	Gravel	1.98	V			
P-64	25.85	38.15	35.00	*	*	0.73	4	Gravel	2.20	V			Mud on bottom
P-65	22.59	53.47	51.00	*	*	0.70	4	Gravel	1.77	V			
P-66	40.04	65.30	63.70	*	*	0.75	4	Gravel	1.25	V			
P-67	39.53	46.50	63.70	*	*	*	*	Gravel	1.65	V			
P-68	62.53	97.00	95.00	*	*	0.75	4	Gravel	1.70	V			Soft bottom
P-69	DRY	110.93	111.00	*	*	0.75	4	Gravel	2.00	V			
P-70	61.78	74.60	67.00	*	*	0.75	4	Gravel	2.00	V			
P-71	68.53	80.20	78.00	*	*	0.75	4	Gravel	~2.45	V			Sandy sediment on bottom
P-72	53.40	91.43		*		0.75	3	Gravel	~2.45	ES			Silty bottom
P-73	53.10	84.95		*	*	0.75	3	Gravel	~2.45	ES			Silty bottom
P-74	48.01	89.98		*		0.75	3	Gravel	~2.45	ES			
P-75	57.82	109.66		*		0.75	3	Gravel	~2.45	ES			
P-76	**Well Abandoned**												
P-77	35.34	72.83		*		0.75	3	Gravel	~2.45	ES			
P-78	58.32	92.90		*	*	0.75	3	Gravel	~2.45	ES			Silty bottom
P-79	43.57	107.20		*		0.75	3	Gravel	~2.2	ES			
P-80	59.74	97.96		*		0.75	3	Gravel	~2.45	ES			Sediment on bottom
P-81	51.28	94.58		*		0.75	3	Gravel	~1.5	ES			Sediment on bottom
P-82	68.88	100.86		*		0.75	3	Gravel	~2.45	ES			Soft bottom
P-83	70.50	125.14		*		0.75	3	Gravel	~2.45	ES			

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3.3.2 Topographic Surveying

Existing groundwater monitoring wells on ALAAP originally were located using a local grid system intrinsic to the ALAAP facility. Land surveying was conducted using a combination of conventional ground surveying and global positioning system (GPS) surveying to relocate the existing and newly installed wells and staff gauges using ASPCS. New locations were surveyed at the end of each phase so that water level data could be continually updated and evaluated. Horizontal locations were surveyed to within 1 foot horizontal accuracy. Ground surface elevations, top of the polyvinyl chloride (PVC) well casing elevations, and staff gauge elevations were surveyed to within 0.05-foot vertical accuracy. Well survey data are summarized in Section 4 and provided in Appendix B. Topographic surveying for this investigation was completed by Ray, Peoples, and White (currently Ray and Gilliland) of Sylacauga, Alabama. Coordinate information was obtained using the 1983 North American Datum in the ASPCS (east) and the National Vertical Geodetic Datum (NVGD) of 1929.

3.4 FIELD SCREENING

Field screening activities were conducted as part of the investigation to obtain real-time data that could be used to make in-field decisions on the presence and extent of contamination and the location of additional sampling points. A geophysical survey and chemical field screening were implemented at various study areas on ALAAP. Chemical field screening for explosives and lead in soils and sediment was conducted primarily during Phase 1 of the RI. Field screening of groundwater samples for explosives was conducted during Phase 2. Some surface water, soils, and sediment samples also were collected and field screened for explosives during Phase 2. The following sections detail the methods and procedures used to screen environmental samples. The results of the field screening are discussed in Section 4 and provided in Appendix C.

3.4.1 Geophysical Surveys

Geophysical surveys were conducted at three former UST locations and a former gas station on ALAAP during Phase 1. These locations included Building 302B, Building 715C, an abandoned gas station, and Building 720D (see Figure 3-4). Buildings 302B and 715C and the abandoned gas station were identified during the CERFA investigation as locations where USTs had been removed, and Building 720D was the site of a suspected UST (TETC 1994). The geophysical surveys were conducted to confirm the removal of the USTs at the CERFA-identified UST sites and the former gas station and to determine if an UST existed at Building 720D.

The geophysical surveys at the sites were conducted using a Geonics EM31-D non-contacting terrain conductivity meter and/or a Schonsted MAC-51B heli-flux magnetometer. The magnetometer generally was used at the sites with the most dense ground cover (i.e., the abandoned gas station site). The objective of the survey was to use the conductivity meter and/or magnetometer to identify qualitatively the presence or absence of a large subsurface metal object (i.e., UST).

The surveys at Buildings 302B and 715C and the former gas station included traversing in an east-west, north-south direction throughout the entire suspected UST removal area. Readings were monitored continuously during the site walkover. None of the readings from either the conductivity meter or the magnetometer identified the presence of a buried metal object. These results substantiate the claim that the USTs had been removed from the CERFA sites.

Since the exact location of the suspected UST at Building 720D was unknown, random locations were surveyed throughout the site. Both the conductivity meter and the magnetometer were used to conduct the survey. The survey identified the presence of a buried object, presumed to be an UST, approximately 50 feet southeast of Building 720D. The four corners of this anomaly were marked. This UST subsequently was excavated and removed by the U.S. Army Corps of Engineers (USACE).

3.4.2 Chemical Field Screening

During previous soil investigations at ALAAP, a limited number of surface locations were sampled near historical buildings and facilities. Depending on the specific analyses conducted, previously collected data are useful indicators of the nature of contamination, but have limited use for determining the horizontal or vertical extent of contamination. Consequently, for Phase I, a program was developed to field screen soil and sediment samples to allow rapid evaluation of the horizontal and vertical extent of contamination. Field screening techniques also were used during Phase 2 to screen soil and water samples collected from monitoring wells, creeks, drainage ditches, and soil borings. Based on the contaminants detected during previous investigations, the following field screening methods were chosen for application at ALAAP during the Phase 1 field investigation (see **Table 3-12**).

Table 3-12. Field Screening Methods
Alabama Army Ammunition Plant, Childersburg, Alabama

Contaminant	Method
TNT	Jenkins method (USACE 1990)
Total PCBs	DTECH® field test kits (SW846 4020)
VOCs	Organic vapor analyzer (photoionization detector)
Lead	Rapid (3-day) laboratory analysis (USAEC ICAP Method JS14)

Screening of surface and subsurface soils during Phase 1 fulfilled different objectives. TNT, PCB, and lead field screening of surface soil collected on systematic sampling grids was used to:

- Determine the horizontal extent of TNT, PCB, and lead contamination
- Assist in the placement of soil borings used to investigate the vertical extent of TNT, PCB, and lead contamination

- Evaluate the occurrence of TNT contamination and its distribution in stream and ditch sediments.

- Determine the degree of PCB contamination associated with downed utility poles and transformer storage buildings.

Field screening and lead analyses of subsurface soils collected from soil borings were used to determine the vertical extent of contamination detected in surface soil samples.

The objective of field screening of soil, in situ borehole water, and groundwater samples for explosives during Phase 2 was to help locate the source of explosives contamination in the groundwater in the southern part of Area B and help place the new monitoring wells. In addition, field screening for explosives was used to determine if a correlation existed between explosives concentrations detected in the groundwater and the subsurface soils.

The methods used for explosives, PCB, and lead screening are discussed below. Appendix C presents tables of complete Phase 1 and Phase 2 field screening results and associated QC data. The field screening results for the Area B study areas are provided in Section 4.

3.4.2.1 Explosives Screening – Phase 1

The Jenkins method (USACE 1990) was used to estimate the concentration of explosives in soil and sediment samples during the Phase 1 field screening activities. The Jenkins method is based on observations made by Janovsky as early as 1891, which noted the colored reaction products formed when polynitroaromatic compounds react with alkali, such as potassium hydroxide (USACE 1990). Soil and sediment samples were analyzed by the Jenkins method in an onsite field laboratory. Modifications were made to the method during the course of the investigation to facilitate the rapid analysis of the samples. This section summarizes the Jenkins procedure for soil and sediment samples and describes deviations from the procedure and their impact on the results.

The Jenkins method for soil and sediment involves the following general steps:

- Extract a 20g subsample of undried soil into 100 mL of acetone to extract explosives.

- Filter the acetone extract and measure background absorbance at 540 nm.

- Add sodium sulfite (Na_2SO_3) and potassium hydroxide (KOH) to the extract and shake the solution for 3 minutes.

- Filter the resulting colored complex solution and measure the absorbance at 540 nm.

- Double the initial sample background absorbance and subtract it from the final colored complex solution absorbance. This absorbance is converted to a TNT concentration relative to the prepared standards.

Interferences associated with the Jenkins analytical procedure include other nitroaromatic compounds that are evidenced by colored reaction when processed through the procedure. Tetryl (orange), 1,3,5-trinitrobenzene (1,3,5-TNB) (red), 1,3-dinitrobenzene (1,3-DNB) (purple), 2,4-DNT (blue), and 2,6-DNT (pinkish/purple) concentrations, if present, may have contributed to the sample absorbance and were calculated as TNT. The screening method for explosives was not conducted to differentiate or estimate the concentrations of various nitroaromatic compounds. Combinations of nitroaromatic compounds within a sample would be expected to show colorimetric changes that are intermediate between the anticipated reaction colors for an individual compound. Color changes were noted by the laboratory analyst in the field log for each analysis. Additional nitroaromatics, including cyclotrimethylenetrinitramine (RDX), cyclotetramethylenetetranitramine (HMX), nitrobenzene, o-nitrotoluene, m-nitrotoluene, p-nitrotoluene, nitroglycerine, 4-A-2,6-DNT, and 2-A-2,6-DNT, if present, have not been observed to exhibit similar color development and would not contribute to the color intensity. Humic (acid) organic matter in soil is extracted to some degree and yields a yellow color that becomes darker when the procedure reagents are added (see **Table 3-13**).

Table 3-13. Colors Exhibited by Target and Nontarget Compounds in the Jenkins Method for Soil Alabama Army Ammunition Plant, Childersburg, Alabama

Extract Color	Explosive Compound	Absorbance Spectrum
Orange	Tetryl	460, 550 nm
Red	Trinitrobenzene	460, 560 nm
Purple/Purplish-blue	Dinitrobenzene	570 nm
Blue	2,4-Dinitrotoluene	570 nm
Pinkish-purple	2,6-Dinitrotoluene	550 nm
Red	Trinitrotoluene	540 nm
Yellow	Humic acid	N/A

Source: USACE 1991.

The field screening for TNT using the Jenkins method was implemented as SAIC FTP-971 (SAIC 1995d). In the field laboratory, sample extracts were filtered through a 0.5-micron disposable analytical vacuum filtration unit instead of the 0.5 micron Millex SR syringe filter recommended by Jenkins. This modification accelerated the filtration procedure, allowing samples to be processed more rapidly. In addition, filtered acetone extracts were placed in disposable 40-mL borosilicate glass vials with caps instead of being filtered directly into a cuvette. This modification allowed the analyst to prepare larger batches of samples and reduced the potential for cross-contamination in the laboratory. Reagents were added directly to the glass vials, which then were capped and shaken. This solution was poured immediately into a clean cuvette and the final absorbance was recorded. A field screening quality assurance (QA) study (Appendix C) was conducted to document that these changes did not impact the obtained results.

Phase 1 Sampling Rationale and Procedures—The size of a contaminated "hot spot" that can be detected with a specified level of confidence (Gilbert 1987) was determined based on the establishment of a predetermined sampling grid size. The distance between grid points also was assumed to be much larger than the actual sample collected using a core. Using grid spacings of 200 to 500 feet and a specified probability of detecting a circular hot spot with the specified size of 0.8 (8 chances in 10), a 200-foot grid spacing was selected. The 200-foot grid spacing was selected based on an analysis of the concentration variance for historical contaminants at a specific site. The use of the larger (500-foot) grid spacing for some areas was based on non-manufacturing site use and a low historical concentration of contaminants.

During the Phase 1 investigation, it was decided that a probability of not finding a hot spot of 20 percent with a diameter of 200 to 250 feet was sufficient for delineating the extent of contamination and developing remedial alternatives. When screening samples collected on the 500-foot grid indicated the presence of explosives exceeding the PRG for TNT for residential or industrial use (depending on the location of the study area), the following decision methodology was used for further screening:

- If any two adjacent points exceeded the criteria, no further screening between the points was conducted. The entire 500-foot area between the points was considered to exceed the criteria.

- If any two adjacent points did not exceed the criteria, no further screening between the points was conducted. The entire 500-foot area between the points was considered to be "clean."

- If, for any two adjacent points, one exceeded the criteria and the other did not, a sample was collected at one-half the distance (250 feet) between the points. If this sample exceeded the criteria, samples were collected at two points 250 feet from this location and perpendicular to a line between the two points whose concentrations exceeded the criteria. This process continued until either two points exceeding the criteria were adjacent, two points not exceeding the criteria were adjacent, or the distance was 250 feet.

The starting point for each sampling grid within a study area was determined using a random coordinate within the study area. The remaining grid points then were fixed around this location using surveying instruments and adhering to the pre-specified grid spacing. Due to dense foliage, some grids were set with a compass and measuring tape. Each grid point was marked with a wooden stake labeled with a local grid coordinate.

Soil Screening—Surface soil samples were collected for screening using decontaminated, stainless steel sampling tools (i.e., spoons, trowels, and bowls). The surface layer (0 to 0.5 feet BLS) of organic material or gravel was scraped away, if necessary, with a sampling tool prior to collecting

the sample. The sample material for the explosives screening was homogenized in a decontaminated, stainless steel bowl and placed into its respective sample container. Subsurface soil samples (1 to 5 feet BLS) were collected using decontaminated, stainless steel hand augers, trowels, spoons, and bowls. To facilitate the collection of samples in densely compacted and/or rocky material, a two-man, gasoline-powered auger was used to drill to the desired sampling depth. Samples then were collected using a decontaminated, stainless steel hand auger. Deeper subsurface soil samples were obtained during drilling of shallow (25-foot deep) borings. Samples were hand delivered to the field laboratory by the field sample collection teams. The designated team leader provided a chain-of-custody that was signed and dated when the samples were relinquished to a field laboratory analyst. The analyst then prioritized the samples and began the analyses.

Sediment Sampling—Sediment screening samples were obtained from onsite and offsite streams, creeks, ditches, and basins along variably spaced (200 feet to 0.5 miles) transects oriented perpendicular to the stream, creek, or ditch. Sediment screening samples in the Red Water Storage Basin, Aniline Basin, and Beaver Ponds were obtained on 200-foot grid patterns. Five sediment locations ("A," "B," "C," "D," and "E") were sampled along each transect line intersecting the respective stream. Sampling points were determined by facing upstream; sample "A" was collected on the top of the left bank; "B" was collected at the foot of the left bank; "C" was collected directly in the center of the stream bed; "D" was collected at the foot of the right bank; and "E" was collected on the top of the right bank. Samples "A" and "E" were composite samples of three locations on the top of the banks. Samples "B," "C," and "D" were collected from a single location.

The sediment samples were collected using decontaminated stainless steel hand augers, spoons, and trowels. Samples for VOC analysis were placed directly into the appropriate sample container. Samples for the remaining analyses (SVOC, hexavalent chromium, metals, explosives, TOC, and pesticides/PCBs) were placed in a decontaminated stainless steel bowl, homogenized, and placed into the laboratory-specified sample containers. For deep streams and creeks (water greater than 3 feet deep), a 10-foot section of piping with a sample jar bound to one end with decontaminated stainless steel clasps was used to collect the sample. All environmental samples were packed in coolers with ice, maintained at a temperature of 4°C ±2°C, and shipped to the appropriate analytical laboratory. Analytical laboratories included ESE of Gainesville, Florida and PACE Environmental Laboratories of Minneapolis, Minnesota.

3.4.2.2 Explosives Screening – Phase 2

During the Phase 2 investigation, both solid and liquid samples were screened for explosives in the field using methods developed by Jenkins. The following sections discuss the methods and procedures used during Phase 2 for the screening analysis of subsurface soil, in situ borehole water, groundwater, sediment, and surface water.

Subsurface Soil and Sediment—The Jenkins method (USACE 1990) used during the Phase 1 investigation for field screening of surface soil, subsurface soil, and sediment is described in Section 3.4.2.1. The same method was used during Phase 2 for the field screening of subsurface

soil and sediment. There were, however, two differences between the Phase 1 and 2 soil screening programs. The first difference was that during Phase 2, analysis was conducted for 2,4-DNT as well as TNT because the results of the Phase 1 screening and confirmatory sample analyses indicated that 2,4-DNT could be a significant component of the soil and sediment contamination. The second difference was the purpose of the screening. While the objective of the soil and sediment Phase 1 screening program was to define the lateral and vertical extent of contamination, the objective of Phase 2 was to provide data for the placement of additional groundwater monitoring wells.

The colorimetric interference of humic acid with TNT discussed in Section 3.4.2.1 applies to 2,4-DNT as well. However, the 2,4-DNT analysis is affected to a lesser degree by humic acid interference. Soil moisture in the sample affects the strength of the 2,4-DNT reaction with the strong base. The ideal soil moisture content is 10 percent; higher or lower moisture levels dampen the reactivity.

Groundwater, In Situ Borehole Water, and Surface Water—A method similar to the Jenkins soil screening method was implemented during Phase 2 for onsite screening of water (groundwater, in situ borehole water, and surface water). The water method was also developed by Jenkins (USACE 1994). The Jenkins method for the analysis of water samples involves the following general steps:

- Allow the sample to settle for several hours, and filter with a glass fiber filter if necessary.
- Set up a filter apparatus with a 1-liter vacuum flask for membrane solid-phase extraction. Condition and rinse the extraction disk filter. Never let the filter go dry.
- Immediately begin filtering the sample through the extraction disk using the vacuum pump.
- Elute the extracted analytes from the membrane with 20 mL of acetone.
- Filter the elution if cloudy, using a 0.45μm syringe filter.
- Record the background absorbance of the extract. Multiply by two and record.
- Add 0.2 g of sodium sulfite and two pellets of potassium hydroxide to 10 mL of the extract; cap and shake for 3 minutes.
- Read the absorbance of the extract. Record the number and subtract from it two times the background absorbance.
- If the color is blue or purple, read the absorbance at a 570 nm wavelength, for 2,4-DNT. If it is pink, read it at 540 nm, for TNT.

- Let the sample stand for 30 minutes to allow maximum color development and reread the absorbance.

- If the absorbance exceeds the spectrophotometer range, dilute a portion of the extract and repeat the reaction.

- Calculate the concentration of the sample from the absorbance of the extract.

The Jenkins field screening method for TNT in groundwater (USACE 1994) is based on the same Janovsky absorbance as that used for screening solid (i.e., soil and sediment) samples. The method for screening groundwater samples was modified for use at ALAAP through collaboration with Thomas Jenkins and through field laboratory testing of the modifications. The method was modified in the following ways:

- The Jenkins method recommended glass fiber filters on all samples being analyzed. Glass fiber filters were not used due to the color changes caused by the filters and the long filtration time caused by the small size of the filter and overload of the filter due to suspended solids. Nylon (Nalgene, 0.45 μm) filters were used in place of glass fiber filters. In addition, the water samples were allowed to settle for several hours, if cloudy. A volumetric test was conducted, which included screening identical samples both with and without the glass fiber filtration. The results of this test showed that the glass fiber filtration of groundwater samples did not affect the results.

- The Jenkins method is designed to use two stacked stryenedivinylbenzene (SDVB) filters, one to screen for the presence of TNT and one to screen for the presence of RDX. During the Phase 2 investigation, one filter was used to screen for the presence of TNT and DNT. The second filter designed to adsorb RDX was not necessary because RDX is not a chemical of concern at ALAAP.

- The original 2-liter volume of sample recommended by Jenkins was modified to 500 mL after conducting a volumetric test. The volumetric test included analyzing the same groundwater sample using different volumes of sample (i.e., 2,000, 1,000, 500, 250, 150, and 100 mL). The results indicated that a 500 mL sample yielded comparable results to the required 2-liter volume. A series test was conducted to assess the potential for explosives to escape through the Empore extraction disk. A 500 mL sample was run through three filters in series and the results showed that 98.4 percent of the explosives were extracted from the sample by the first filter.

The interference of other nitroaromatic compounds with the absorbance spectrum of TNT, discussed in Section 3.4.2.1, applies to the water methods as well as the soil. However, the interference of humic acid is rarely encountered, even in very turbid borehole water samples. In

addition, the filtering process can add a light green hue to the extract, but it does not interfere in the 570 nm wavelength.

3.4.2.3 Lead Screening

During previous investigations at ALAAP, lead was identified as a contaminant in several study areas. After considering the possibility of onsite analysis of lead samples using x-ray fluorescence (XRF) instrumentation, rapid lead screening analysis provided by a fixed laboratory was determined to be more cost effective. PACE Environmental Laboratories was contracted to analyze lead samples during Phase 1 and provide results to the Field Manager within 3 days. Soil samples for rapid lead analysis were collected using methods described in Section 3.4.2.1 for TNT screening. Lead analyses were conducted for surface and subsurface soil samples at six study areas (see Table 3-1).

Quantitative lead analyses were conducted using inductively coupled argon plasma (ICAP) emission spectroscopy. Under the ICAP method, the certified reporting limit (CRL) for lead was 10.0 μg/g and the upper certified reporting limit (UCRL) was 500 μg/g. The method uses sample digestion using nitric and hydrochloric acids followed by digestate analysis with ICAP. Specifically, a 1-gram subsample of soil was digested in a combination of nitric acid, hydrogen peroxide, and hydrochloric acid solutions. Each sample was diluted to a final volume of 100 mL and ICAP emission spectroscopy was used to quantify lead concentrations. Sample moisture content (%) was determined and applied to the final result to obtain dry weight concentrations. QC samples consisting of a standard matrix method blank, a standard matrix spike at approximately 2 times the CRL, and duplicate standard matrix spikes at approximately 10 times the CRL were analyzed daily. The QC samples were processed through the entire method with the environmental samples.

3.4.2.4 PCB Field Screening

During the Phase 1 investigation, 27 downed utility pole locations and 2 former transformer buildings were identified as potential sources of PCB contamination of surface and subsurface soil. Samples from these locations were analyzed for PCBs using the DTECH® field screening method (SW846 Method 4020). PCB field screening was initiated in visually stained areas and proceeded out from those areas. The number of screening samples was reduced to 95 samples (from the proposed 270 PCB screening samples) to be analyzed because of the nondetection of PCB contamination by the DTECH® test kits in visually stained areas. Ten percent of the samples were sent to the fixed laboratory for confirmation. Subsurface soil was screened every 5 feet for PCB contamination.

The DTECH® PCB screening method is based on an enzyme linked immunosorbent assay (ELISA). The test is equally sensitive for the most commonly found PCBs, including Aroclor-1254, Aroclor-1242, Aroclor-1248, Aroclor-1260, and Aroclor-1268. Reactivity to Aroclor-1232 is approximately 5-fold less and reactivity to Aroclor-1016 and Aroclor-1221 is approximately 10-fold less. With the test kit, antibodies specific to PCBs are linked to latex

particles. PCB molecules present in the sample are retained by the latex particles and collected on the membrane surface of the collection device. A color developing solution then is added, and the presence (or absence) of PCBs is measured with a hand-held DTECHTOR® meter for semiquantitative results. The working range for the kit is 0.5 to 25 parts per million (ppm) for PCBs in soil. Soil extraction is completed by using the DTECH® PCB Soil Extraction Pac. The resulting methanol extract is subject to color development using the DTECH® PCB Test Kit. Color development is inversely proportional to the concentration of PCBs present in the sample. Based on the screening results, 10 percent of the samples with concentrations exceeding 50 ppm were sent to the fixed laboratory for quantitative analysis. Soil samples for PCB screening were collected using the methods described in Section 3.4.2.1 for TNT screening.

3.4.2.5 Volatiles Screening

Sample screening for VOCs occurred during drilling and sampling activities using an HNu photoionization detector (PID). The HNu probe was scanned over the exposed sample upon opening of split spoons to obtain a qualitative indication for the presence of VOCs. Soil samples in which elevated concentrations of VOCs were detected by the PID were selected for laboratory analysis.

3.5 GEOLOGICAL/GEOTECHNICAL INVESTIGATIONS

This section discusses the methods used for the geological and geotechnical investigations conducted at ALAAP. Specifically, methods for sampling surface soil, sediment, subsurface soil, surface water, and groundwater are presented. In addition, the techniques used to assess the physical and chemical properties of soil are discussed.

3.5.1 Surface Soil Sampling

The horizontal extent of contamination in surface soils (0 to 0.5 feet BLS) was determined at the appropriate study area by screening on systematically aligned square grids with grid lines spaced at 200 to 500 feet, depending on the study area size. A systematic approach was selected to obtain uniform coverage of the study areas and estimate the extent and volume of contamination. Following the soil screening, 10 to 20 percent of the total number of surface soil samples from all study areas (except the CERFA sites) were analyzed for VOCs, SVOCs, metals, explosives, explosives breakdown products, and TOC. In addition, 12 soil samples were analyzed for hexavalent chromium from the study areas identified in Table 3-1 and the background location. Pesticides/PCBs were analyzed in all samples collected from Study Area 3 and the background locations. The number of samples collected, screened, and analyzed from each study area was proportional to the actual size of the individual areas.

Surface soil samples were collected using decontaminated, stainless steel sampling tools (i.e., spoons, trowels, and bowls). The surface layer (0 to 0.5 feet BLS) of organic material or gravel was scraped away, if necessary, with a sampling tool prior to collecting the sample. Surface

soil samples were collected from 0 to 0.5 feet BLS in the absence of loose surface material. Samples designated for VOC analyses were placed directly into sample containers. The sample material for the remaining analyses (SVOCs, metals, hexavalent chromium, explosives, TOC, and pesticides/PCBs) was homogenized in a decontaminated, stainless steel bowl and placed into its respective sample container.

All soil samples were labeled before shipment to the analytical laboratories. The labels were completed with the installation name, project number, location, sample date/time, media type, method matrix, site identification (ID), site type, field sample number, depth, sample technique, analysis, preservative, comments, and collector's initials. Clear tape was used to secure sample container labels to the bottles to prevent inadvertent label removal due to moist or wet conditions occurring during storage or shipment of the samples. The locations of the surface soil samples are shown in Figure 3-1.

3.5.2 Subsurface Soil Sampling

Previous investigations at ALAAP consisted primarily of the collection of surface soil samples. This sampling scheme did not identify the horizontal or vertical extent of contamination. Consequently, the present investigation included drilling soil borings and collecting subsurface samples to assess the horizontal and vertical extent of contamination. During the Phase 1 investigation, the placement of soil borings was determined based on field screening results from surface soil samples. Samples collected from soil borings were analyzed at a laboratory for explosives and explosives byproducts, VOCs, SVOCs, TOC, and metals except for samples collected from CERFA sites and background site locations. Samples were analyzed for pesticides, PCBs, total petroleum hydrocarbons (TPH), nitrates (NO_3), phosphates (PO_4), and hexavalent chromium (Cr^{+6}) in selected study areas. Background locations were sampled and analyzed for a full suite of contaminants. The above analyses were selected based on historical information and data from previous investigations to evaluate the existence of any possible contamination from previous site activities. Table 3-1 summarizes the analyses conducted during the Phase 1 investigation at the soil boring site locations.

Soil samples were collected from 1 to 5 feet BLS using decontaminated, stainless steel hand augers, trowels, spoons, and bowls. To facilitate the collection of samples in densely compacted and/or rocky material, a two-man, gasoline-powered auger was used to drill to the desired sampling depth. Samples then were collected using a decontaminated, stainless steel hand auger.

As part of the Phase 1 investigation, subsurface soil samples were collected for chemical analysis at 14 study areas, 5 CERFA site locations, and 2 background locations. A total of 65 soil borings were drilled in Area B (see Figure 3-2). Sixty-four soil borings were screened and sampled for chemical analysis and the lithology was logged. Soil samples were collected every 5 feet. **Table 3-14** summarizes the soil borings drilled during Phase 1 in each study area, samples collected, sample depth, and chemical analyses conducted. Samples were selected for quantitative

Table 3-14. Soil Boring Analyses: Study Areas, CERFA, and Background Sites – Phase 1
Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area	Borehole ID	Total Sample Depth	Intervals Sampled	Intervals Analyzed	Metals	SVOCs	TOC	VOCs	Cr+6	Explosives	Pesticides/ PCBs	PCB	TPH	NO3/ PO4	pH
2	SB-02-001	27	6	2	1,6	1,6	1,6	1,6		1,6					
	SB-02-002	22	5	3	1,3,5	1,3,5	1,3,5	1,3,5		1,3,5					
	SB-02-003	27	6	2	1,6	1,6	1,6	1,6		1,6					
	SB-02-004	27	6	2	1,6	1,6	1,6	1,6		1,6					
3	SB-03-005	27	6	6	1,3,6	1,3,6	1,3,6	1,3,6	1	1,3,6	1,3,6				1,2,3,4,5,6
	SB-03-006	27	6	2	1,6	1,6	1,6	1,6	1	1,6	1,6				
	SB-03-007	27	6	6	1,4,6	1,4,6	1,4,6	1,4,6	1	1,4,6	1,3,6				1,2,3,4,5,6
4	SB-04-008	27	6	6	1,6	1,6	1,6	1,6		1,6					1,2,3,4,5,6
	SB-04-009	27	6	6	1,4,6	1,4,6	1,4,6	1,4,6		1,4,6					1,2,3,4,5,6
	SB-04-010	27	6	6	1,4,6	1,4,6	1,4,6	1,4,6		1,4,6					1,2,3,4,5,6
6	SB-06-011	27	6	2	1,6	1,6	1,6	1,6		1,6					
	SB-06-012	27	6	2	1,6	1,6	1,6	1,6	1	1,6					
	SB-06-013	27	6	2	1,6	1,6	1,6	1,6		1,6					
	SB-06-014	27	6	2	1,6	1,6	1,6	1,6		1,6					
	SB-06-015	27	6	2	1,6	1,6	1,6	1,6	1	1,6					
7	SB-07-016	27	6	2	1,6	1,6	1,6	1,6	1	1,6					
	SB-07-017	27	6	2	1,6	1,6	1,6	1,6	1	1,6					
	SB-07-018	27	6	2	1,6	1,6	1,6	1,6		1,6					
	SB-07-019	12	3	2	1,3	1,3	1,3	1,3		1,3					
	SB-07-020	27	6	3	1,2,6	1,2,6	1,2,6	1,2,6		1,2,6					
8	SB-08-021	27	6	6	1,6	1,6	1,6	1,6	1	1,6					
	SB-08-022	22	5	5	5	5	5	5		5					
	SB-08-023	27	6	6	1,6	1,6	1,6	1,6	1	1,6					
	SB-08-024	27	6	6	1,6	1,6	1,6	1,6		1,6					
	SB-08-025	27	6	6	1,6	1,6	1,6	1,6		1,6					
10	SB-10-026	27	6	3	1,4,6	1,4,6	1,4,6	1,4,6		1,4,6					
	SB-10-027	17	4	3	1,2,4	1,2,4	1,2,4	1,2,4		1,2,4					
	SB-10-028	27	6	3	1,4,6	1,4,6	1,4,6	1,4,6		1,4,6					
	SB-10-029	27	6	3	1,4,6	1,4,6	1,4,6	1,4,6		1,4,6					
	SB-10-030	27	6	3	1,5,6	1,5,6	1,5,6	1,5,6		1,5,6					
	SB-10-045	27	6	3	1,5,6	1,5,6	1,5,6	1,5,6		1,5,6					
16	SB-16-031	17	4	4	1,4	1,4	1,4	1,4		1,4					1,2,3,4
	SB-16-032	27	6	6	1,6	1,6	1,6	1,6		1,6					1,2,3,4,5,6

Table 3-14. Soil Boring Analyses: Study Areas, CERFA, and Background Sites – Phase 1 Alabama Army Ammunition Plant, Childersburg, Alabama (Continued)

Study Area	Borehole ID	Total Sample Depth	Intervals Sampled	Intervals Analyzed	Metals	SVOCs	TOC	VOCs	Cr+6	Explosives	Pesticides/ PCBs	PCB	TPH	NO3/ PO4	pH
16	SB-16-033	17	4	4	1,4	1,4	1,4	1,4		1,4					1,2,3,4
	SB-16-042	27	6	6	1,6	1,6	1,6	1,6		1,6					1,2,3,4,5,6
	SB-16-061	6	2	2	1	1	1	1		1					1,2
	SB-16-062	9	3	2	1,3	1,3	1,3	1,3		1,3					1,3
	SB-16-063	14	4	4	1	1	1	1		1					1,2,3,4
	SB-16-064	14	4	4	1	1	1	1		1					1,2,3,4
17	SB-17-034	27	6	2	1,6	1,6	1,6	1,6		1,6					
	SB-17-035	27	6	2	1,6	1,6	1,6	1,6		1,6					
	SB-17-036	27	6	2	1,6	1,6	1,6	1,6		1,6					
	SB-17-039	27	6	2	1,6	1,6	1,6	1,6		1,6					
	SB-17-065	22	5	3	1,3,6	1,3,6	1,3,6	1,3,6		1,3,6					
18	SB-18-037	27	6	2	1,6	1,6	1,6	1,6	1	1,6					
	SB-18-038	27	6	2	1,6	1,6	1,6	1,6		1,6					
19	SB-19-040	27	6	4	1,6	1,6	1,6	1,6		1,6					1,3,4,6
	SB-19-041	27	6	6	1,2	1,2	1,2	1,2	1	1,2					1,2,3,4,5,6
20	SB-20-043	26	6	2	1,6	1,6	1,6	1,6		1,6					
	SB-20-044	27	5	2	1,5	1,5	1,5	1,5		1,5					
22	SB-22-047	27	6	6	1,3,6	1,3,6	1,3,6	1,3,6	1	1,3,6					1,2,3,4,5,6
	SB-22-048	12	3	3	1,2,3	1,2,3	1,2,3	1,2,3	1	1,2,3					1,2,3
	SB-22-049	27	6	6	1,4,6	1,4,6	1,4,6	1,4,6		1,4,6					1,2,3,4,5,6
25	SB-25-050	12	3	3	1,2,3	1,2,3	1,2,3	1,2,3	1	1,2,3					1,2,3
	SB-25-051	22	5	5	1,3,5	1,3,5	1,3,5	1,3,5	1	1,3,5					1,2,3,4,5
	SB-25-052	17	4	4	1,4	1,4	1,4	1,4		1,4					1,2,3,4
CERFA															
Coke Oven	SB-B6-055	27	6	2	1,6	1,6	1,6	1,6	1	1,4,6					
	SB-B6-056	27	6	3	1,4,6	1,4,6	1,4,6	1,4,6	1	1,6					
Poles	SB-PO-057	27	6	2	1,6							1,6			
Gas Station	SB-GS-058	27	6	2	1,6	1,6							1,6		
Pest/Fert	SB-PS-059	27	6	3	1,2,6						1,2,6				
	SB-PS-060	27	6	3	1,2,6						1,2,6				

Table 3-14. Soil Boring Analyses: Study Areas, CERFA, and Background Sites – Phase 1 Alabama Army Ammunition Plant, Childersburg, Alabama (Continued)

Study Area	Borehole ID	Total Sample Depth	Intervals Sampled	Intervals Analyzed	Metals	SVOCs	TOC	VOCs	Cr+6	Explosives	Pesticides/ PCBs	PCB	TPH	NO3/ PO4	pH
BACKGROUND															
	SB-BK-001	27	9	6	1,2,3,4,6,8	1,2,3,4,6,8	1,2,3,4,6,8	1,2,3,4,6,8	1	1,2,3,4,6,8	1,2,3,4,6,8			1	
	SB-BK-054	27	6	6	1,2,3,4,5,6	1,2,3,4,5,6	1,2,3,4,5,6	1,2,3,4,5,6	1	1,2,3,4,5,6	1,2,3,4,5,6			1	

NOTES:

Samples were collected at sample intervals (1) 1 to 3 feet, (2) 5 to 7 feet, (3) 10 to 12 feet, (4) 15 to 17 feet, (5) 20 to 22 feet, and (6) 25 to 27 feet BLS, unless refusal or the groundwater table was encountered.

Samples were collected at sample intervals (1) 1 to 3 feet, (2) 4 to 6 feet, (3) 7 to 9 feet, and (4) 12 to 14 feet BLS at SB-16-061 through SB-16-064.

Background soil boring SB-BK-001 was drilled and sampled to a depth of 42 feet and sample interval (8) is 35 to 37 feet BLS.

laboratory analysis based on field screening results. Confirmatory laboratory analyses were conducted on approximately 30 percent of the field screened samples. A maximum of three samples were sent from each soil boring to the laboratory for quantitative analysis. Samples were selected and sent to the laboratory from the top and bottom intervals of each borehole and from an interval that exhibited elevated concentrations of contamination during field screening. If contamination was not detected during soil screening, a sample was retained from the top and bottom interval of each borehole and sent for laboratory analysis.

Six CERFA soil boring locations were selected using biased sampling techniques. Soil boring locations were based on visual identification of contamination (i.e., soil staining) and historical knowledge of areas where previous facility operations or activities occurred. Five soil borings were drilled at the locations of a former coke oven, gas station, transformer storage locations, and pesticide storage area. Biased sampling techniques were used because these areas had not been previously evaluated.

During the Phase 2 investigation, soil boring locations were determined from the Phase 1 investigation findings. The soil borings were placed downgradient from study areas in which the presence of elevated concentrations of explosives in the groundwater was suspected. Soil borings were drilled to a depth where the water table was encountered. Split spoon samples were not collected in the residuum during Phase 2 because the focus was to investigate contamination near and at the water table. During drilling of the soil boring, a subsurface soil sample was collected when groundwater was encountered at a location in or just above the saturated zone. In addition, a water sample was obtained from the groundwater that accumulated within the borehole. Both the soil and groundwater samples were screened in the field for explosives using the Jenkins methods for field screening (USACE 1990). Soil samples with detected explosive compounds were sent to the laboratory for confirmatory analysis. In some instances, neither a soil nor water sample could be obtained because the water table was not encountered prior to encountering bedrock or auger refusal. **Table 3-15** summarizes the soil borings drilled, sampling depth, and site IDs for the Phase 2 subsurface investigation.

3.5.2.1 Soil Boring Drilling Procedures

Soil boring operations were conducted during Phase 1 between March and August 1995. Christensen Boyles Corporation of Murfreesboro, Tennessee conducted the drilling operations. Soil borings were drilled using 6¼ inch outside diameter (O.D.), True Spin, continuous flight, hollow-stem augers. Soil samples were collected using 3-inch O.D. stainless steel split spoons. Samples generally were collected at 5-foot intervals. Soil borings were advanced and soil samples were collected to a total sample depth of 27 feet BLS, unless refusal or the groundwater table was encountered. Samples were collected for chemical and geotechnical analysis at each boring.

The Phase 2 investigation was conducted between May and July 1996 by Layne Christensen Corporation (formerly Christensen Boyles Corporation) of Murfreesboro, Tennessee. Soil borings

Table 3-15. Soil Borings, Summary of Subsurface Field Screening Analysis – Phase 2 Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area	Borehole ID	Sample Depth (feet BLS)		Analysis
		Soil	Borehole Water	Explosives
2	SB-02-066	1-27[a]	20.9	✓
	SB-02-069	62-64	**	✓
	SB-02-070	47-49	**	✓
	SB-02-072		25.4	✓
	SB-02-074	33-35	18.1	✓
16	SB-16-001[c]	48.5-50.5		See note b.
	SB-16-003[c]			
	SB-16-004			
	SB-16-006[c]			
	SB-16-007[c]			
17	SB-17-080		**	✓
	SB-17-081	43-45	55.6	✓
	SB-17-082		44.0	✓
	SB-17-083[c]		46.1	✓
	SB-18-086	48-50	30.2	✓
18	SB-18-076[c]	51	**	✓
	SB-18-077[c]	53-55	52.0	See note b.
	SB-18-078[c]		**	✓
	SB-18-079		35.5	✓
	SB-18-084	48-50	49.4	✓
	SB-18-085	43-45	28.1	✓
20	SB-18-087	38-40	29.1	✓

BLS = Below Land Surface
** = Sample was screened, but sample depth was not recorded.
a = Screened from 1 to 3, 5 to 7, 10 to 12, 15 to 17, 20 to 22, and 25 to 27 feet BLS.
b = Quick-turn analysis for explosives conducted at laboratory.
c = Confirmatory analysis conducted; samples analyzed for explosives and lead.

were drilled using the same drilling technique and equipment used during Phase 1. During Phase 2, 19 soil borings were drilled into or just above the soil/bedrock interface. A soil sample was collected at or just above the static water table and a water sample was collected from the borehole annulus to identify if explosives contamination was present and migrating along the soil/bedrock interface. Split spoon samples, however, only were collected for sampling purposes and lithology was logged from cuttings.

3.5.3 Monitoring Well Drilling and Installation

Thirty shallow (residuum) and 10 deep (bedrock) monitoring wells were drilled and installed at 11 study areas and a background location during Phase 1 of the Supplemental RI. The

monitoring wells were installed to obtain hydrogeologic and hydrochemical information in study areas that previously had not been investigated. The final well locations, depths, and screened intervals were determined based on encountered field conditions, such as inaccessible areas, refusal, and void spaces in the subsurface.

During the Phase 2 and Phase 3 field activities, 21 monitoring wells were drilled and installed in the southern portion of Area B. During Phase 2, five wells were placed near Study Areas 16 and 19 to investigate the potential for migration of explosives from the area toward Study Areas 17 and 18 and further west toward the Coosa River. One monitoring well was installed in Study Area 2 during the Phase 2 investigation. During Phase 3, 15 monitoring wells were placed at strategic locations in the southern portion of Area B to verify or define the presence of explosives and lead contamination in the groundwater identified during Phases 1 and 2. Well locations were selected to target possible source areas and fill data gaps identified in these areas.

During Phase 1, shallow monitoring wells were drilled using a Mobil B-61 auger/core rig and continuous flight hollow-stem augers. Well screens (10-foot screened interval, 0.01-inch slot size) were placed from 5 to approximately 15 feet below the groundwater table. Sand pack was installed from the bottom of the borehole to 5 feet above the well screen. Well screens and sand pack were installed in this manner to compensate for lower water levels encountered during the summer months when sampling occurred. Initially, large diameter 8¾ inch O.D. augers were used to drill and sample shallow well locations. Smaller diameter 6¼ inch O.D. augers were used as field activities progressed because they allowed for a more competent borehole and the efficient installation of sand pack.

Deep wells were drilled and installed in bedrock during Phase 1 using a Schramm Rotadrill Model 450 air rotary drilling rig and an Odex drilling system. The Odex drilling system advances an air hammer, drill string, bit, and outside casing simultaneously down the borehole, sealing the borehole annulus from flowing, viscous materials and cave-in, which might bind the drill string and bit while drilling. After contact with competent bedrock, the outer Odex casing was advanced 2 to 7 feet into competent bedrock to seal the borehole annulus before rock coring. Once the outer casing (Odex) casing was in place, rock cores were collected using an NX size casing, bit, and wireline retrieval system. Approximately 30 feet of rock core were collected and logged at each deep well location. Core recoveries were minimal from highly fractured subsurface zones or where subsurface cavities were encountered.

Deep well screens were set across possible water-bearing zones (i.e., fractures and void space). A 20-foot screen was placed in bedrock at all deep well locations except wells GW-08-02BR and GW-BK-02BR. A 30-foot screened section was used at GW-08-02BR to isolate a void space, which produced a large volume of water during drilling activities. A grout basket was placed in wells with large voids (i.e., GW-BK-02BR, GW-10-03BR, and GW-17-09BR) because installing sand pack was not possible. During well installation, field crews were unable to advance well screen and casing at well GW-BK-02BR due to an obstruction in the borehole. A 10-foot

section of screen was installed at this location. Some bedrock well boreholes that did not initially produce water were observed overnight to assess the potential for groundwater production.

The six wells installed during the Phase 2 well drilling activities at Study Areas 2, 16, and 19 were installed in the same manner as Phase 1 activities. Split spoon samples, however, only were collected for sampling purposes and lithology was logged from cuttings.

Fifteen shallow wells were installed during the Phase 3 drilling activities using an auger and/or air rotary drill rig with an Odex casing (outer) advancement system. Weathered rock (refusal) or competent bedrock was encountered during Phase 2 activities before reaching the water table while drilling boreholes at several planned well locations. For this reason, wells were installed during Phase 3 using a combination or air and auger drilling techniques to sufficiently penetrate the groundwater table in any situation, specifically in the south to southeast portion of Area B where the groundwater table is deeper below land surface and in the bedrock only. Shallow wells were drilled in areas of low topography in Area B with an auger rig where the static water table exists primarily in the residuum. In areas where topographic highs exist onsite and the water table is within bedrock, an air rotary rig with an Odex casing advancement system was employed to penetrate bedrock and provide an open competent borehole for well installation across the soil bedrock interface (i.e., casing off flowing soil and gravel along the soil bedrock interface). The borehole then was advanced a sufficient depth into bedrock to screen off the top 10 to 15 feet of the static water table. If well locations drilled with the auger rig encountered refusal before entering the water table, the air rotary drill rig was set up on the auger rig location to complete drilling and well installation into rock.

During the Phase 2 and 3 investigations, monitoring wells were constructed with prepacked wells screens because of the difficulty installing sand pack at the bedrock/soil interface during the Phase 1 investigation. The prepacked screens were constructed of PVC using a 10-foot screened interval, 0.01-inch slot size, 6 inch O.D., and 4 inch inside diameter (I.D.). After the prepacked well screen was installed, a sand pack was installed in the surrounding well annulus and filled a volume approximately 5 feet above the top of the well screen. These modifications to the original USAEC well construction requirements were approved by the USAEC geologist.

3.5.3.1 Well Construction and Development

Well construction was initiated following the sampling of each borehole to the completion depth. Wells were constructed with schedule 40 PVC riser and screen. The slot size for well screens was 0.010 inches. Sand pack consisted of #5 global filter pack and the sand packs were installed a minimum of 5 feet above the screened sections. Bentonite seals consisting of pellets or slurry were installed a minimum of 5 feet above the sand pack. If field conditions warranted changes in the portions of sand pack, bentonite seal, or screen length, variations from the standard well construction were documented and implemented after verbal discussions with USAEC or a geotechnical representative. The borehole annulus above each well seal was filled with a grout mixture consisting of a bentonite/cement slurry mix required by USAEC specifications. Monitoring

wells then were secured with a concrete pad, protective casing, and steel posts. Drilling, well construction logs, and well development records for each installed boring and monitoring well are provided in Appendices D and E.

Well development was initiated at all newly installed monitoring wells 48 hours after the placement of the internal mortar collar in accordance with USAEC protocols. The wells were developed using either a submersible stainless steel pump and/or a PVC bailer, depending on the productivity of the well. The newly installed wells were developed by removing a minimum of five times the volume of standing water in the well, including the saturated annulus. Additional water volumes equivalent to five times the volume of drilling fluid losses to the borehole were removed as part of the well development. Specific conductivity, pH, and temperature measurements were obtained periodically during the well development process. Stabilization of these parameters were used, in addition to produced groundwater volumes, as criteria for determining development completion. Groundwater clarity was qualitatively observed and documented during development. A groundwater sample from the developed well was archived onsite. The developed water initially was containerized in drums. The drums later were pumped into a large polyethylene tank and transported to the onsite permitted facility for treatment and disposal. Well development data are presented in Appendix G.

3.5.4 Groundwater Sampling

Prior to the collection of groundwater samples and at least 2 weeks after well development, each well was purged in accordance with the procedures outlined in the Supplemental RI/FS SAP/Work Plan (SAIC 1995a). Static water level measurements were taken in each well using an electric water level indicator. Depths to groundwater were used to calculate the well depths, borehole diameter, volume of standing water in each well, and required purge volume.

For wells that recovered to the original static water level within 24 hours, at least five well volumes of water were purged from each well before samples were collected. For wells with slow purge and recovery rates, wells were purged to dryness. If the well volume did not return to 90 percent of the initial well volume within 1 hour, the well was pumped to dryness a second time and sampled within 24 hours. If the well volume recovered to at least 90 percent of the initial well volume, five well volumes of water were pumped before sampling. This modification to the purging and sampling procedure was approved by the USAEC geologist. Purging was conducted using a decontaminated, stainless steel Grundfos variable speed pump or a decontaminated PVC bailer. Field measurements for temperature, pH, and specific conductivity were monitored during purging to ensure that these parameters had stabilized prior to sampling. Well purging ensured that a representative sample of the aquifer water (i.e., not stagnant well water) was collected. Well purge water was containerized in 55-gallon drums at each well. The purge water from these drums later was pumped into a large polyethylene tank and transported to the onsite permitted facility for treatment and disposal.

Groundwater samples were collected from the well as soon after purging as there was a sufficient volume of water in the well for the intended analyses. **Table 3-16** provides the chemical analyses that were conducted for the groundwater samples during each phase of field investigation. Groundwater was obtained using disposable point-source, bottom-filling Teflon® bailers. Each sample container was triple rinsed with water from the well to be sampled. Preserved VOC vials were not triple rinsed due to the presence of preservative in the bottles. After the bottles had been rinsed properly, groundwater samples were collected and dispensed directly into the appropriately labeled sample bottles. A sample was collected to measure the final temperature, pH, and specific conductance immediately after sample collection. Groundwater clarity was qualitatively observed and documented during development.

Prior to the Phase 2 field operations in March 1996, groundwater data were collected for eight wells located on the Alliance Coosa Pines Facility (formerly Kimberly-Clark) parcel and analyzed for explosives, explosives breakdown products, and lead. Two of the Alliance Coosa Pines (formerly Kimberly-Clark) wells were sampled during the Phase 3 activities in January 1997 and sampled for explosives, explosives breakdown products, and lead.

3.5.5 Surface Water/Sediment Sampling

Twenty-nine surface water locations (see Sheet 3-4) were identified for sampling during the Phase 1 investigation to characterize water quality and estimate the contaminant contributions from each drainage area. These locations were sited to evaluate contamination from each standing water body and major tributary in Area B and assess potential contamination entering the Coosa River, Talladega Creek, and Little Blue Creek. Surface water samples collected during Phase 1 were analyzed for VOCs, SVOCs, metals, total metals, hexavalent chromium, pesticides/PCBs, and explosives and their byproducts. During Phase 2, surface water samples were collected from the Coosa River and several low-lying wetland areas in the southern portion of ALAAP – Area B (see Sheet 3-4). These samples were collected to evaluate the potential for contaminant migration from the groundwater to surface water bodies within and downgradient from ALAAP – Area B. Analytical parameters for each study area where surface water samples were collected are shown in Table 3-1. Analytical parameters for the surface water samples collected during Phases 2 and 3 are listed in Tables 3-2 and 3-3, respectively.

Sediment samples were collected from the onsite streams and ditches at 200- or 500-foot intervals (depending on the location and length of stream) along transects perpendicular to the site ditches and the Beaver Pond Drainage (see Sheet 3-2). For every tenth transect, sediment samples were collected and analyzed in the laboratory for VOCs, SVOCs, metals, hexavalent chromium, TOC, pesticides/PCBs, and explosives and their byproducts to quantitatively characterize the nature of potential contaminants present in the sediments. During the Phase 2 investigation, several sediment samples were collected from Study Area 21 and the low-lying wetland areas in the southern portion of ALAAP – Area B (see Sheet 3-3). These sediment samples were collected to evaluate the potential for contaminant migration from the groundwater to surface water bodies and

Table 3-16. Well Samples and Analyses
Alabama Army Ammunition Plant, Childersburg, Alabama

Samples							Water Analyses											
SA	Site Type	Site ID	Field Sample	Date	Flag	Depth	Cr^{+6}	VOC	EXP	NO_3	P/PCB	PAH	PCP	PO_4	SVOCs	Total Metals	Pb Only	TOC
JANUARY '95 – PHASE I																		
3	WELL	P-60	SAIC01	1/13/95		5.15		✓	✓			✓	✓		✓	✓		
4	WELL	D-10	SAIC01	1/9/95		80.10		✓	✓			✓	✓		✓	✓		
	WELL	P-5	SAIC01	1/13/95		29.04		✓	✓			✓	✓		✓	✓		
5	WELL	P-31	SAIC01	1/9/95		11.42		✓	✓			✓	✓		✓	✓		
	WELL	P-31	SAIC02	1/9/95	D	11.42		✓	✓			✓	✓		✓	✓		
	WELL	P-7	SAIC01	1/16/95		8.02		✓	✓			✓	✓		✓	✓		
6	WELL	D-4	SAIC01	1/10/95		15.45		✓	✓			✓	✓		✓	✓		
	WELL	D-6	SAIC01	1/11/95		6.62		✓	✓			✓	✓		✓	✓		
	WELL	P-10	SAIC01	1/10/95		19.75		✓	✓			✓	✓		✓	✓		
	WELL	P-10	SAIC01	1/10/95	F	19.75										✓		
	WELL	P-35	SAIC01	1/11/95		35.31		✓	✓			✓	✓		✓	✓		
	WELL	P-36	SAIC01	1/11/95		18.26		✓	✓			✓	✓		✓	✓		
	WELL	P-62	SAIC01	1/11/95		29.24		✓	✓			✓	✓		✓	✓		
7	WELL	D-11	SAIC01	1/9/95		92.10		✓	✓			✓	✓		✓	✓		
	WELL	D-12	SAIC01	1/12/95		45.57		✓	✓			✓	✓		✓	✓		
	WELL	D-3	SAIC01	1/11/95		57.96		✓	✓			✓	✓		✓	✓		
	WELL	D-7B	SAIC01	1/11/95		126.26	✓	✓	✓			✓	✓		✓	✓		
	WELL	D-7B	SAIC01	1/11/95		126.26		✓	✓			✓	✓		✓	✓		
	WELL	P-11	SAIC01	1/15/95		11.58		✓	✓			✓	✓		✓	✓		
	WELL	P-12	SAIC01	1/13/95		19.48		✓	✓			✓	✓		✓	✓		
	WELL	P-41	SAIC01	1/13/95		12.52		✓	✓			✓	✓		✓	✓		
	WELL	P-41	SAIC02	1/13/95	D	12.52		✓	✓			✓	✓		✓	✓		
	WELL	P-52	SAIC01	1/10/95		18.68	✓	✓	✓			✓	✓		✓	✓		
	WELL	P-52	SAIC01	1/10/95	F	18.68										✓		
	WELL	P-52	SAIC01	1/10/95		18.68	✓	✓	✓			✓	✓		✓	✓		
	WELL	P-52	SAIC01	1/10/95	F	18.68										✓		
	WELL	P-52	SAIC02	1/10/95	D	18.68	✓	✓	✓			✓	✓		✓	✓		

Table 3-16. Well Samples and Analyses
Alabama Army Ammunition Plant, Childersburg, Alabama (Continued)

Samples							Water Analyses											
SA	Site Type	Site ID	Field Sample	Date	Flag	Depth	Cr^{+6}	VOC	EXP	NO_3	P/PCB	PAH	PCP	PO_4	SVOCs	Total Metals	Pb Only	TOC
JANUARY '95 – PHASE I (Continued)																		
7	WELL	P-52	SAIC02	1/10/95	DF	18.68										✓		
	WELL	P-61	SAIC01	1/15/95		18.76		✓	✓			✓	✓		✓	✓		
	WELL	P-63	SAIC01	1/13/95		22.03		✓	✓			✓	✓		✓	✓		
	WELL	P-64	SAIC01	1/15/95		22.24		✓	✓			✓	✓		✓	✓		
8	WELL	P-13	SAIC01	1/15/95		15.23		✓	✓			✓	✓		✓	✓		
	WELL	P-14	SAIC01	1/15/95		16.24		✓	✓			✓	✓		✓	✓		
9	WELL	P-17	SAIC01	1/15/95		11.02		✓	✓			✓	✓		✓	✓		
10	WELL	D-13	SAIC01	1/15/95		23.16		✓	✓			✓	✓		✓	✓		
	WELL	D-13	SAIC01	1/15/95		23.16		✓	✓			✓	✓		✓	✓		
	WELL	D-13	SAIC02	1/15/95	D	23.16		✓	✓			✓	✓		✓	✓		
	WELL	D-14	SAIC01	1/13/95		42.64		✓	✓			✓	✓		✓	✓		
	WELL	D-14	SAIC01	1/13/95	F	42.64										✓		
	WELL	P-44	SAIC01	1/15/95		11.75		✓	✓			✓	✓		✓	✓		
	WELL	P-65	SAIC01	1/15/95		19.91		✓	✓			✓	✓		✓	✓		
	WELL	P-66	SAIC01	1/13/95		40.35		✓	✓			✓	✓		✓	✓		
16	WELL	D-16	SAIC01	1/17/95		59.01		✓	✓			✓	✓		✓	✓		
	WELL	D-17	SAIC01	1/17/95		103.82		✓	✓			✓	✓		✓	✓		
	WELL	P-26	SAIC01	1/17/95		48.66		✓	✓			✓	✓		✓	✓		
	WELL	P-68	SAIC01	1/17/95		58.40		✓	✓			✓	✓		✓	✓		
	WELL	P-69	SAIC01	1/17/95		106.00		✓	✓			✓	✓		✓	✓		
17	WELL	D-15	SAIC01	1/16/95		36.05		✓	✓			✓	✓		✓	✓		
	WELL	P-67	SAIC01	1/16/95		34.74		✓	✓			✓	✓		✓	✓		
	WELL	P-82	SAIC01	1/12/95		77.15		✓	✓			✓	✓		✓	✓		
	WELL	P-82	SAIC01	1/12/95		77.15		✓	✓			✓	✓		✓	✓		
	WELL	P-82	SAIC02	1/12/95	D	77.15		✓	✓			✓	✓		✓	✓		
19	WELL	D-18	SAIC01	1/16/95		55.02		✓	✓			✓	✓		✓	✓		
	WELL	D-19	SAIC01	1/17/95		77.65		✓	✓			✓	✓		✓	✓		

Table 3-16. Well Samples and Analyses
Alabama Army Ammunition Plant, Childersburg, Alabama (Continued)

Samples							Water Analyses											
SA	Site Type	Site ID	Field Sample	Date	Flag	Depth	Cr^{+6}	VOC	EXP	NO_3	P/PCB	PAH	PCP	PO_4	SVOCs	Total Metals	Pb Only	TOC
JANUARY '95 PHASE 1 (Continued)																		
19	WELL	P-70	SAIC01	1/16/95		57.95		✓	✓			✓	✓		✓	✓		
	WELL	P-71	SAIC01	1/16/95		68.02		✓	✓			✓	✓		✓	✓		
21	WELL	D-9	SAIC01	1/8/95		55.20		✓	✓			✓	✓		✓	✓		
	WELL	P-32	SAIC01	1/13/95		13.87		✓	✓			✓	✓		✓	✓		
	WELL	P-8	SAIC01	1/9/95		18.90		✓	✓			✓	✓		✓	✓		
27	WELL	P-50	SAIC01	1/11/95		11.02	✓	✓	✓			✓	✓		✓	✓		
	WELL	P-50	SAIC01	1/11/95	F	11.02										✓		
	WELL	P-51	SAIC01	1/15/95		14.31		✓	✓			✓	✓		✓	✓		
BK	WELL	D-20	SAIC01	1/17/95		116.00		✓	✓			✓	✓		✓	✓		
	WELL	P-83	SAIC01	1/12/95		67.18		✓	✓			✓	✓		✓	✓		
	WELL	P-83	SAIC01	1/12/95	F	67.18										✓		
	WELL	P-84	SAIC01	1/13/95		100.11		✓	✓			✓	✓		✓	✓		
MAY '95 TO AUGUST '95 – PHASE 1																		
2	WELL	GW-02-001	SAIC01	5/18/95		18.17		✓	✓		✓	✓	✓		✓	✓		
	WELL	GW-04-001	SAIC01	5/22/95		22.77	✓	✓	✓						✓	✓		
	WELL	GW-04-001	SAIC01	5/22/95	F	22.77										✓		
	WELL	GW-21-002	SAIC01	8/22/95		0.00		✓	✓		✓				✓	✓		
	WELL	GW-21-002	SAIC01	8/22/95	F	0.00										✓		
	WELL	GW-21-01BR	SAIC01	8/1/95		0.00	✓	✓	✓						✓	✓		
	WELL	GW-21-01BR	SAIC01	8/1/95	F	0.00										✓		
3	WELL	GW-03-001	SAIC01	5/25/95		12.79		✓	✓						✓	✓		
	WELL	GW-03-002	SAIC01	6/7/95		0.00		✓	✓						✓	✓		
	WELL	GW-03-003	SAIC01	5/30/95		61.40		✓	✓						✓	✓		
	WELL	GW-03-004	SAIC01	5/18/95		9.75		✓	✓		✓	✓	✓		✓	✓		
	WELL	P-60	SAIC02	5/25/95		7.52		✓	✓			✓			✓	✓		
4	WELL	D-10	SAIC02	5/21/95		68.62			✓						✓	✓		
	WELL	GW-04-003	SAIC01	5/17/95		42.75		✓	✓			✓	✓		✓	✓		

Table 3-16. Well Samples and Analyses
Alabama Army Ammunition Plant, Childersburg, Alabama (Continued)

Samples							Water Analyses											
SA	Site Type	Site ID	Field Sample	Date	Flag	Depth	Cr^{+6}	VOC	EXP	NO_3	P/PCB	PAH	PCP	PO_4	SVOCs	Total Metals	Pb Only	TOC
MAY '95 TO AUGUST '95 – PHASE I (Continued)																		
4	WELL	GW-04-004	SAIC01	5/18/95		16.95		✓	✓			✓	✓		✓	✓		
	WELL	GW-04-02BR	SAIC01	7/31/95		22.23		✓	✓						✓	✓		
	WELL	GW-05-001	SAIC01	6/7/95		0.00		✓	✓						✓	✓		
5	WELL	P-7	SAIC02	5/24/95		12.20		✓	✓						✓	✓		
6	WELL	D-6	SAIC01	5/19/95		0.00		✓	✓			✓	✓		✓	✓		
	WELL	GW-06-002	SAIC01	6/6/95		0.00		✓	✓						✓	✓		
	WELL	P-10	SAIC02	5/23/95		17.40	✓	✓	✓			✓	✓		✓	✓		
	WELL	P-10	SAIC02	5/23/95	F	17.40										✓		
	WELL	P-10	SAIC03	5/23/95	D	17.40	✓	✓	✓			✓	✓		✓	✓		
	WELL	P-10	SAIC03	5/23/95	DF	17.40										✓		
	WELL	P-35	SAIC01	5/21/95		10.20		✓	✓			✓			✓	✓		
	WELL	P-62	SAIC01	5/22/95		30.67		✓	✓						✓	✓		
7	WELL	D-7B	SAIC01	5/23/95		92.58	✓	✓	✓		✓				✓	✓		
	WELL	D-7B	SAIC01	5/23/95	F	92.58										✓		
	WELL	D-7B	SAIC01	5/23/95		92.58	✓	✓	✓		✓				✓	✓		
	WELL	D-7B	SAIC01	5/23/95	F	92.58										✓		
	WELL	P-11	SAIC02	5/22/95		13.54	✓	✓	✓						✓	✓		
	WELL	P-12	SAIC01	5/21/95		20.80		✓	✓			✓			✓	✓		
	WELL	P-41	SAIC03	5/24/95		13.51		✓	✓			✓			✓	✓		
	WELL	P-52	SAIC03	5/22/95		18.92		✓	✓			✓			✓	✓		
	WELL	P-61	SAIC01	5/21/95		226.90		✓	✓						✓	✓		
	WELL	P-63	SAIC02	5/24/95		23.00		✓	✓			✓			✓	✓		
	WELL	P-64	SAIC01	5/22/95		26.10		✓	✓				✓		✓	✓		
8	WELL	GW-06-001	SAIC01	6/6/95		0.00	✓	✓	✓		✓				✓	✓		
	WELL	GW-06-001	SAIC01	6/6/95	F	0.00										✓		
	WELL	GW-08-001	SAIC01	6/7/95		0.00		✓	✓						✓	✓		
	WELL	GW-08-001	SAIC01	6/7/95	F	0.00										✓		

Table 3-16. Well Samples and Analyses
Alabama Army Ammunition Plant, Childersburg, Alabama (Continued)

Samples							Water Analyses											
SA	Site Type	Site ID	Field Sample	Date	Flag	Depth	Cr^{+6}	VOC	EXP	NO_3	P/PCB	PAH	PCP	PO_4	SVOCs	Total Metals	Pb Only	TOC
MAY '95 TO AUGUST '95 – PHASE 1 (Continued)																		
8	WELL	GW-08-02BR	SAIC01	7/28/95		0.00		✓	✓		✓				✓	✓		
	WELL	P-13	SAIC02	5/31/95		22.51		✓	✓						✓	✓		
10	WELL	GW-10-001	SAIC01	5/17/95		11.62		✓	✓			✓	✓		✓	✓		
	WELL	GW-10-001	SAIC01	5/17/95	F	11.62										✓		
	WELL	GW-10-002	SAIC01	5/19/95		0.00		✓	✓			✓	✓		✓	✓		
	WELL	GW-10-004	SAIC01	5/21/95		8.32		✓	✓			✓	✓		✓	✓		
	WELL	GW-10-004	SAIC02	5/21/95	D	8.32		✓	✓			✓	✓		✓	✓		
	WELL	GW-10-005	SAIC01	5/24/95		18.92		✓	✓			✓			✓	✓		
	WELL	GW-10-005	SAIC02	5/24/95	D	18.92		✓	✓			✓			✓	✓		
	WELL	GW-10-006	SAIC01	5/19/95		0.00		✓	✓			✓	✓		✓	✓		
	WELL	GW-10-03BR	SAIC01	8/1/95		0.00		✓	✓			✓	✓		✓	✓		
	WELL	GW-10-03BR	SAIC01	8/1/95		0.00						✓						
	WELL	P-44	SAIC02	5/21/95		22.13		✓	✓				✓		✓	✓		
16	WELL	D-16	SAIC02	5/22/95		60.19		✓	✓						✓	✓		
	WELL	P-68	SAIC02	5/22/95		59.43		✓	✓		✓	✓	✓		✓	✓		
	WELL	P-68	SAIC02	5/22/95	F	59.43										✓		
	WELL	P-69	SAIC02	5/24/95		106.12		✓	✓			✓			✓	✓		
17	WELL	D-15	SAIC02	5/25/95		37.02		✓				✓			✓	✓		
	WELL	GW-17-002	SAIC01	5/30/95		18.00		✓	✓						✓	✓		
	WELL	GW-17-003	SAIC01	5/18/95		27.63		✓	✓			✓	✓		✓	✓		
	WELL	GW-17-004	SAIC01	5/19/95		0.00		✓	✓			✓	✓		✓	✓		
	WELL	GW-17-005	SAIC01	5/22/95		44.43		✓	✓						✓	✓		
	WELL	GW-17-006	SAIC01	5/24/95		30.90		✓	✓						✓	✓		
	WELL	GW-17-09BR	SAIC01	7/31/95		0.00		✓	✓						✓	✓		
	WELL	GW-17-10BR	SAIC01	7/31/95		0.00		✓	✓						✓	✓		
	WELL	P-67	SAIC02	5/21/95		35.14		✓	✓			✓			✓	✓		

Table 3-16. Well Samples and Analyses
Alabama Army Ammunition Plant, Childersburg, Alabama (Continued)

Samples							Water Analyses											
SA	Site Type	Site ID	Field Sample	Date	Flag	Depth	Cr^{+6}	VOC	EXP	NO_3	P/PCB	PAH	PCP	PO_4	SVOCs	Total Metals	Pb Only	TOC
MAY '95 TO AUGUST '95 – PHASE 1 (Continued)																		
18	WELL	GW-18-001	SAIC01	5/31/95		41.66		✓	✓						✓	✓		
	WELL	GW-18-001	SAIC01	5/31/95	F	41.66										✓		
	WELL	GW-18-001	SAIC02	5/31/95	D	41.66		✓	✓						✓	✓		
	WELL	GW-18-001	SAIC02	5/31/95	DF	41.66										✓		
	WELL	GW-18-002	SAIC01	5/24/95		10.58		✓	✓			✓			✓	✓		
19	WELL	P-70	SAIC01	5/25/95		57.90		✓	✓			✓			✓	✓		
	WELL	P-70	SAIC01	5/25/95	F	57.90										✓		
20	WELL	GW-18-003	SAIC01	5/25/95		46.30		✓	✓						✓	✓		
	WELL	GW-20-002	SAIC01	9/1/95		20.50					✓							
	WELL	GW-20-01BR	SAIC01	8/2/95		0.00		✓	✓						✓	✓		
	WELL	GW-20-03BR	SAIC01	7/31/95		0.00		✓	✓		✓	✓	✓		✓	✓		
21	WELL	D-9	SAIC02	5/25/95		27.00		✓	✓			✓			✓	✓		
	WELL	D-9	SAIC02	5/25/95	F	27.00										✓		
	WELL	P-8	SAIC01	5/23/95		13.86		✓	✓						✓	✓		
	WELL	P-8	SAIC01	5/23/95	F	13.86										✓		
27	WELL	D-4	SAIC01	5/21/95		14.69		✓	✓				✓		✓	✓		
	WELL	P-50	SAIC01	5/21/95		11.53		✓	✓			✓			✓	✓		
	WELL	P-51	SAIC02	5/21/95		14.86		✓	✓						✓	✓		
	WELL	P-51	SAIC03	5/21/95	D	14.86		✓	✓						✓	✓		
BK	WELL	D-20	SAIC02	5/30/95		114.98		✓	✓			✓	✓		✓	✓		
	WELL	GW-BK-001	SAIC01	6/7/95		0.00	✓	✓	✓		✓	✓	✓		✓	✓		
	WELL	GW-BK-001	SAIC01	6/7/95	F	0.00										✓		
	WELL	GW-BK-001	SAIC02	6/7/95	D	0.00		✓	✓		✓	✓	✓		✓	✓		
	WELL	GW-BK-02BR	SAIC01	8/1/95		0.00	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
	WELL	GW-BK-02BR	SAIC01	8/1/95	F	0.00										✓		
	WELL	GW-BK-02BR	SAIC02	8/1/95	D	0.00							✓					
	WELL	P-84	SAIC02	5/30/95		101.83		✓	✓			✓			✓	✓		

Table 3-16. Well Samples and Analyses
Alabama Army Ammunition Plant, Childersburg, Alabama (Continued)

Samples							Water Analyses											
SA	Site Type	Site ID	Field Sample	Date	Flag	Depth	Cr^{+6}	VOC	EXP	NO_3	P/PCB	PAH	PCP	PO_4	SVOCs	Total Metals	Pb Only	TOC
MARCH '96 TO JULY '96 – PHASE 2																		
2	WELL	GW-02-001	SAIC02	5/30/96		15.62			✓								✓	
	WELL	GW-02-002	SAIC02	6/3/96		34.72			✓								✓	
	WELL	GW-02-003	SAIC01	7/12/96		10.09			✓								✓	
	WELL	GW-02-003	SAIC02	7/12/96	D	10.09			✓								✓	
	WELL	GW-02-003	SAIC03	7/25/96		11.84			✓							✓		
	WELL	GW-02-003	SAIC04	7/25/96	D	11.84			✓							✓		
	WELL	GW-04-001	SAIC02	6/4/96		21.52			✓								✓	
	WELL	GW-04-001	SAIC03	6/4/96	D	21.52			✓								✓	
	WELL	GW-21-01BR	SAIC02	6/4/96		44.50			✓								✓	
	WELL	GW-21-01BR	SAIC02	5/30/96		82.52			✓								✓	
3	WELL	GW-03-001	SAIC02	6/4/96		11.57			✓								✓	
	WELL	GW-03-002	SAIC02	6/5/96		38.91			✓								✓	
	WELL	GW-03-003	SAIC02	6/3/96		51.04			✓								✓	
	WELL	GW-03-004	SAIC02	6/5/96		14.40			✓								✓	
4	WELL	GW-04-003	SAIC02	6/2/96		25.32			✓								✓	
	WELL	GW-04-004	SAIC02	6/5/96		22.20			✓								✓	
	WELL	GW-04-02BR	SAIC02	6/4/96		19.30			✓								✓	
	WELL	GW-05-001	SAIC02	6/4/96		17.20			✓								✓	
6	WELL	GW-06-002	SAIC02	6/2/96		10.18			✓								✓	
8	WELL	GW-06-001	SAIC02	5/31/96		16.63			✓								✓	
	WELL	GW-08-001	SAIC02	5/30/96		15.60			✓								✓	
	WELL	GW-08-02BR	SAIC02	5/31/96		16.34			✓								✓	
10	WELL	GW-10-001	SAIC02	6/2/96		5.94			✓								✓	
	WELL	GW-10-002	SAIC02	5/30/96		14.32			✓								✓	
	WELL	GW-10-004	SAIC03	5/31/96		7.39			✓								✓	
	WELL	GW-10-005	SAIC03	5/31/96		16.82			✓								✓	
	WELL	GW-10-006	SAIC02	5/31/96		12.39			✓								✓	
	WELL	GW-10-03BR	SAIC02	5/31/96		54.63			✓								✓	

Table 3-16. Well Samples and Analyses
Alabama Army Ammunition Plant, Childersburg, Alabama (Continued)

Samples							Water Analyses											
SA	Site Type	Site ID	Field Sample	Date	Flag	Depth	Cr^{+6}	VOC	EXP	NO_3	P/PCB	PAH	PCP	PO_4	SVOCs	Total Metals	Pb Only	TOC
MARCH '96 TO JULY '96 – PHASE 2 (Continued)																		
16	WELL	GW-16-002	SAIC01	7/12/96		27.26			✓								✓	
	WELL	GW-16-002	SAIC02	7/25/96		28.90			✓							✓		
	WELL	GW-16-005	SAIC01	7/12/96		85.11			✓								✓	
	WELL	GW-16-005	SAIC02	7/25/96		85.75			✓							✓		
	WELL	GW-16-006	SAIC01	7/12/96		62.48			✓								✓	
	WELL	GW-16-006	SAIC02	7/25/96		61.32			✓							✓		
	WELL	GW-16-007	SAIC01	7/12/96		47.80			✓								✓	
	WELL	GW-16-007	SAIC02	7/25/96		49.11			✓							✓		
	WELL	P-68	SAIC03	6/5/96		59.03			✓								✓	
	WELL	P-69	SAIC03	6/5/96		106.42			✓								✓	
17	WELL	GW-17-002	SAIC02	6/3/96		40.51			✓								✓	
	WELL	GW-17-003	SAIC02	6/2/96		22.67			✓								✓	
	WELL	GW-17-004	SAIC02	5/31/96		47.71			✓									
	WELL	GW-17-004	SAIC02	6/1/96		44.50											✓	
	WELL	GW-17-005	SAIC02	6/2/96		43.54			✓								✓	
	WELL	GW-17-006	SAIC02	6/5/96		38.43			✓								✓	
	WELL	GW-17-09BR	SAIC02	6/5/96		81.20			✓								✓	
	WELL	GW-17-10BR	SAIC02	6/2/96		82.09			✓								✓	
18	WELL	GW-18-001	SAIC03	5/31/96		29.71			✓								✓	
	WELL	GW-18-002	SAIC02	6/2/96		9.74			✓								✓	
20	WELL	GW-18-003	SAIC02	6/2/96		26.21			✓								✓	
	WELL	GW-18-003	SAIC03	6/2/96	D	26.21			✓								✓	
	WELL	GW-20-002	SAIC02	6/3/96		10.35			✓								✓	
	WELL	GW-20-01BR	SAIC02	6/2/96		19.61			✓								✓	
	WELL	GW-20-03BR	SAIC02	6/3/96		6.52			✓								✓	
BK	WELL	GW-BK-001	SAIC03	5/30/96		20.94			✓							✓		
	WELL	GW-BK-001	SAIC04	5/30/96	D	20.94			✓							✓		
	WELL	GW-BK-02BR	SAIC03	5/30/96		22.02			✓							✓		
	WELL	GW-BK-02BR	SAIC04	5/30/96	D	22.02			✓							✓		

Table 3-16. Well Samples and Analyses
Alabama Army Ammunition Plant, Childersburg, Alabama (Continued)

Samples							Water Analyses											
SA	Site Type	Site ID	Field Sample	Date	Flag	Depth	Cr^{+6}	VOC	EXP	NO_3	P/PCB	PAH	PCP	PO_4	SVOCs	Total Metals	Pb Only	TOC
MARCH '96 TO JULY '96 – PHASE 2 (Continued)																		
KC	WELL	MW-10S	SAIC01	3/21/96		44.75			✓								✓	
	WELL	MW2-11S	SAIC01	3/20/96		68.30			✓								✓	
	WELL	MW-12S	SAIC01	3/20/96		87.20			✓								✓	
	WELL	PMW-1	SAIC01	3/21/96		45.54			✓								✓	
	WELL	PMW-3	SAIC01	3/21/96		55.66			✓								✓	
	WELL	PMW-5	SAIC01	3/21/96		47.11			✓								✓	
	WELL	PMW-7	SAIC01	3/21/96		27.21			✓								✓	
	WELL	PMW-8	SAIC01	3/19/96		29.00			✓								✓	
JANUARY '97 – PHASE 3																		
2	WELL	GW-02-001	SAIC03	1/19/97		10.80			✓								✓	
	WELL	GW-02-002	SAIC03	1/16/97		28.85			✓								✓	
	WELL	GW-02-003	SAIC05	1/17/97		3.37			✓								✓	
	WELL	GW-02-005	SAIC01	1/21/97		34.90			✓							✓		
	WELL	GW-04-001	SAIC04	1/15/97		13.00			✓								✓	
	WELL	GW-04-001	SAIC04D	1/15/97	D	13.00			✓								✓	
3	WELL	GW-03-001	SAIC03	1/19/97		6.05			✓								✓	
	WELL	GW-03-002	SAIC03	1/17/97		48.02			✓								✓	
	WELL	GW-03-003	SAIC03	1/16/97		39.00			✓								✓	
	WELL	GW-03-004	SAIC03	1/17/97		4.77			✓								✓	
	WELL	GW-03-005	SAIC01	1/19/97		11.16			✓							✓		
6	WELL	GW-06-002	SAIC03	1/16/97		7.40			✓								✓	
16	WELL	GW-16-002	SAIC03	1/17/97		25.68			✓								✓	
	WELL	GW-16-005	SAIC03	1/17/97		79.79			✓								✓	
	WELL	GW-16-006	SAIC03	1/20/97		59.12			✓								✓	
	WELL	GW-16-006	SAIC03D	1/20/97	D	59.12											✓	
	WELL	GW-16-007	SAIC03	1/19/97		42.65			✓								✓	
	WELL	P-68	SAIC04	1/20/97		55.79			✓								✓	
	WELL	P-69	SAIC04	1/21/97		103.28			✓								✓	

Table 3-16. Well Samples and Analyses
Alabama Army Ammunition Plant, Childersburg, Alabama (Continued)

Samples							Water Analyses											
SA	Site Type	Site ID	Field Sample	Date	Flag	Depth	Cr^{+6}	VOC	EXP	NO_3	P/PCB	PAH	PCP	PO_4	SVOCs	Total Metals	Pb Only	TOC
JANUARY '97 – PHASE 3 (Continued)																		
17	WELL	GW-17-002	SAIC03	1/20/97		36.24			✓								✓	
	WELL	GW-17-003	SAIC03	1/16/97		21.18			✓								✓	
	WELL	GW-17-004	SAIC03	1/17/97		42.26			✓								✓	
	WELL	GW-17-005	SAIC03	1/16/97		33.16			✓								✓	
	WELL	GW-17-006	SAIC03	1/19/97		33.79			✓								✓	
	WELL	GW-17-011	SAIC01	1/16/97		39.06			✓							✓		
	WELL	GW-17-012	SAIC01	1/17/97		33.77			✓							✓		
	WELL	GW-17-013	SAIC01	1/20/97		70.53			✓							✓		
	WELL	GW-17-014	SAIC01	1/16/97		119.45			✓							✓		
	WELL	GW-17-014	SAIC02	1/22/97		120.65			✓							✓		
	WELL	GW-17-015	SAIC01	1/20/97		44.71			✓							✓		
	WELL	GW-17-016	SAIC01	1/22/97		74.28			✓							✓		
	WELL	GW-17-018	SAIC01	1/19/97		10.57			✓							✓		
	WELL	GS-17-019	SAIC01	1/17/97		60.58			✓							✓		
	WELL	P-67	SAIC03	1/20/97		31.55			✓								✓	
	WELL	P-82	SAIC03	1/20/97		97.00			✓								✓	
18	WELL	GW-18-001	SAIC04	1/17/97		35.36			✓								✓	
	WELL	GW-18-001	SAIC04D	1/17/97	D	35.36			✓									
	WELL	GW-18-002	SAIC03	1/16/97		6.25			✓								✓	
	WELL	GW-18-005	SAIC01	1/19/97		55.37			✓							✓		
	WELL	GW-18-005	SAIC01D	1/19/97	D	55.37										✓		
20	WELL	GW-18-003	SAIC04	1/15/97		23.38			✓								✓	
	WELL	GW-18-003	SAIC04D	1/15/97	D	23.28			✓								✓	
	WELL	GW-18-006	SAIC01	1/19/97		19.56			✓							✓		
	WELL	GW-18-007	SAIC01	1/17/97		6.29			✓							✓		
	WELL	GW-20-002	SAIC03	1/17/97		4.58			✓								✓	
22	WELL	GW-22-001	SAIC01	1/21/97		33.77			✓						✓	✓		
	WELL	GW-22-001	SAIC01D	1/21/97	D	33.77			✓									
	WELL	GW-22-002	SAIC01	1/22/97		17.48			✓						✓	✓		

Table 3-16. Well Samples and Analyses
Alabama Army Ammunition Plant, Childersburg, Alabama (Continued)

Samples							Water Analyses											
SA	Site Type	Site ID	Field Sample	Date	Flag	Depth	Cr^{+6}	VOC	EXP	NO_3	P/PCB	PAH	PCP	PO_4	SVOCs	Total Metals	Pb Only	TOC
JANUARY '97 – PHASE 3																		
BK	WELL	GW-BK-001	SAIC05	1/19/97		17.91			✓						✓	✓		
	WELL	GW-BK-001	SAIC05D	1/19/.97	D	17.91			✓						✓	✓		
	WELL	P-83	SAIC02	1/20/97		63.93			✓								✓	
KC	WELL	PMW-1	SAIC02	1/20/97		47.80			✓								✓	
	WELL	PMW-5	SAIC02	1/20/97		46.23			✓								✓	

subsequent deposition in the sediments. All sediment samples were collected from depths of 0 to 6 inches BLS with the exception of the subsurface samples collected from 5 feet BLS at Study Area 21. Analytical parameters for each study area are shown in Table 3-1. Analytical parameters for the sediment samples collected during Phases 2 and 3 are listed in Tables 3-2 and 3-3, respectively.

Sediment samples were collected from Study Area 9 during the Phase 1 investigation; however, the tar-like material was not characterized. Concerns pertaining to disposal of the tar-like material was expressed. Therefore, tar samples and additional sediment samples (below the tar) were collected at Study Area 9 to characterize the tar and evaluate possible leaching into the underlying sediment. The locations of the sediment samples collected during Phase 4A are shown on Sheet 3-3. Sediment samples were collected by removing the layer of tar-like waste material with a backhoe. A sediment sample was collected from the sidewall of the excavation where sediment was discolored or stained. Analytical parameters for the sediment samples collected during Phase 4A are provided in Table 3-4.

3.5.6 Tar Sampling

Tar samples were collected from Study Area 9 during the Phase 4A investigation to characterize the tar-like material and evaluate whether the substance is a hazardous or nonhazardous waste according to RCRA. Two samples were collected from a central area in the tar-like material located in the southern portion of Study Area 9. The sample locations are shown on Sheet 3-3. Because the thickness of the waste material was unknown, an initial boring (hand auger) was advanced to determine the thickness and the appropriate depth from which to collect a representative sample. Samples were collected at 0.5 feet BLS, below the hardened weathered surface of the tar-like waste.

Sample depths were obtained using a hand auger to drill to the selected sample depth. A hand operated slide hammer equipped with a 0.5- to 1-foot core barrel was used to collect the samples. Samples were analyzed for the parameters indicated in Table 3-4.

Using measurements taken in the field, the approximate surface area of the tar-like material was 9,078 square feet. The depth of tar-like material was measured at numerous points in the area and found to be approximately 7 to 12 inches in thickness. The volume of the tar-like material was estimated as approximately 5,295 to 9,078 cubic feet.

In February, Environmental Chemical Corporation (ECC) excavated the tar from the Aniline Sludge Basin (ECC 1999). ECC first set up a 50- by 50-foot grid system. Grids were identified for excavation by collecting preliminary samples that were sent to ADEM for a waste profile approval. When approval was received, grids contaminated with tar were excavated until the tar was no longer visible and then an additional 6 inches of material were excavated. Confirmatory samples were collected and analyzed for metals and SVOCs. The samples showed no exceedances of ADEM's TCLP regulatory limit. The total amount of material excavated was 3,063 cubic yards. The excavation area was then backfilled, compacted, and seeded (ECC 1999).

3.5.7 Test Pit Excavation and Soil Sampling

During the Phase 4A investigation, test pits were excavated at five selected manhole locations. The locations of the manholes are shown in Figure 3-3. Soil was excavated from the outside of each manhole vault. Two samples were collected from each test pit. Soil samples were collected from areas at the base of each vaulted area just below the concrete footer/slab in soils that were stained or discolored. If soil discoloration or staining was not present, one soil sample was collected at the bottom (5 to 10 feet) of the concrete footer at the base of the manhole and the second soil sample was collected at a depth approximately 2 feet below the bottom (8 to 12 feet) of the concrete footer. The 10 soil samples collected from the test pit excavations were sent to the laboratory and analyzed for soil pH, metals, and SVOCs.

The manhole vaults are constructed of fire-retardant brick and mortar and a concrete footer or slab (1 to 2 feet thick) installed at the base of the manhole vault (see Appendix D). At several manhole locations, the concrete and mortar were found in a state of deterioration and decay when the test pits were excavated.

The test pits were excavated using a backhoe at each manhole location; precautions were taken to avoid rupturing the intact sewerlines. The soil was returned as backfill when the pit excavation was complete. The backhoe bucket was used to collect soil from the excavation and the samples were collected directly from this bucket. Care was taken to ensure that soil that had been in contact with the backhoe bucket was not collected as part of the sample. The samples were collected using stainless steel sampling utensils and placed in a stainless steel mixing bowl.

Soils encountered in the test pits were similar and consisted of reddish brown to brownish yellow silty clay. Soil staining and discoloration were present in test pit excavations at locations TP-08-008, TP-08-009, and TP-08-023.

3.5.8 Equipment Decontamination

Drilling equipment (e.g., rig, tools, augers, and bits), well purging equipment, and well screen and casing materials were decontaminated by steam washing the equipment with a laboratory-grade nonphosphorous detergent (i.e., Alconox®) solution and rinsing materials with water from the approved potable source. All drilling equipment was decontaminated between drilling locations. Decontaminated equipment was wrapped in plastic for transport to the site to prevent contamination of the equipment and materials. Sampling and well development equipment (i.e., bailers, core sampler, hand auger, and split spoon samplers) coming in direct contact with the sample media were decontaminated using the procedure listed below:

- Scrub the equipment with a solution of laboratory-grade detergent (Alconox®) using a brush
- Rinse the equipment with potable water

- Rinse the equipment with deionized water
- Rinse the equipment with isopropanol and air dry
- Rinse the equipment with deionized water again, air dry, and wrap in aluminum foil.

Decontamination rinsate from soil sampling activities was collected and containerized pending the results of chemical analyses at the respective study areas. Generated waste streams were segregated by study area to reduce potential disposal quantities. Decontamination rinsate resulting from well development activities was containerized in drums. The drums later were pumped into a large polyethylene tank and transported to the onsite incinerator facility for treatment and disposal.

3.5.9 Geotechnical Testing

Soil and sediment samples were collected from boreholes and surface sampling locations during Phase 1 for the determination of pH (EPA SW846 Method 9045), cation exchange capacity (CEC) (EPA SW846 Method 9080), grain size (ASTM D-422), Atterberg limits (ASTM D-4318), unified soil classification (ASTM D-2488), organic carbon (EPA SW846 Method 9060), and moisture content (ASTM D4959-89). Sediment sample locations included the Aniline Sludge Basin, Red Water Storage Basin, the Beaver Pond Drainage, Crossover Ditch, and Red Water Ditch. Soil samples collected for geotechnical analysis were selected from each study area. During Phase 1, 2 surface soil samples and 38 soil boring samples were analyzed for pH and CEC. Five sediment samples and 55 soil samples from soil borings also were analyzed during the Phase 1 investigation for grain size, Atterberg limits, and unified soil classification. Soil and sediment samples were collected during Phase 1 for geotechnical analysis and selected based on the following criteria:

- Representative samples from each study area
- Samples from soil above and below the groundwater table
- Samples that deviated from typical soils
- Sediment samples.

Geotechnical analyses were completed by Law Engineering of Atlanta, Georgia. Data from these analyses are summarized in Section 4 and Appendix F. No additional geotechnical analyses were conducted during the Phase 2 and Phase 3 investigations.

3.6 HYDROGEOLOGICAL INVESTIGATIONS

The hydrogeology of ALAAP was investigated through quantitative measurements of groundwater and surface water elevations and aquifer testing through slug testing of installed monitoring wells. The results of these measurements were used to construct groundwater flow

maps, map the spatial distribution of hydraulic conductivity values, and estimate groundwater flow velocities.

3.6.1 Groundwater/Surface Water Elevation Measurements

Eleven rounds of groundwater elevation measurements were obtained between September 1994 and January 1997 from existing wells installed by ESE in both Areas A and B, and from each RI monitoring well installed in 1995, 1996, and 1997. Manual water level measurements were obtained using electronic sounding devices and the measured groundwater depths were referenced in all instances to the surveyed top of the PVC well casing. Ten continuous water level recorders were installed in strategic wells. Five of the recorders were mechanical Stevens continuous chart recorders installed in GW-17-004, GW-04-003, P-11, GW-06-001, and P-26. The mechanical recorder installed in P-26 later was moved to GW-16-007. The other five recorders were digital Stevens 420 Data Loggers installed in GW-17-09BR, GW-04-02BR, GW-20-03BR, GW-10-001, and GW-20-002, and were programmed to measure water levels every half hour. The digital recorder installed in GW-20-002 later was moved to GW-16-002. Data were collected from the water level recorders every 30 days between August 1995 and May 1997. Groundwater elevation measurements are provided in Section 4 and Appendix G.

Six rounds of groundwater elevation measurements were obtained between November 1995 and January 1997 from 12 wells located on the Alliance Coosa Pines Facility (formerly Kimberly-Clark) parcel south of ALAAP. Partial survey data were provided by Kimberly-Clark for selected wells, and the remaining locations were estimated by transferring the mapped locations from maps provided by Kimberly-Clark to a historical map of the ALAAP facility. Top of casing elevations were provided by Kimberly-Clark and measured depths to water (below top of casing [BTOC]) were obtained by SAIC personnel under the supervision of Kimberly-Clark.

Seven rounds of surface water measurements were obtained between June 1995 and December 1996 from 12 staff gauges installed during the RI activities. Staff gauge measurements were obtained by measuring the depth to water below a surveyed point on the staff gauge. These gauges were used to determine the variability of the surface water levels within the pond areas. Surface water level data are provided in Section 4 and the locations of the staff gauges are shown on Sheet 3-4.

3.6.2 Slug Testing

Aquifer slug tests were conducted on 42 groundwater monitoring wells at ALAAP (see **Table 3-17**) during the Phase 1 Supplemental RI field effort to determine the hydraulic conductivity of the screened aquifer. Slug tests were not conducted on the monitoring wells installed during Phases 2 or 3. Slug tests were conducted to measure the rate of recovery in wells after a known volume of water is added (falling head test) or removed (rising head test). Rising head permeability slug tests were conducted at ALAAP and well recharge measurements were collected to within 90 percent of the static water level.

Table 3-17. Slug Tests Conducted in Monitoring Wells During Phase 1 Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area	Well Number	Slug Test Conducted
2	GW-02-001	✓
	GW-02-002	✓
3	GW-03-001	✓
	GW-03-002	✓
	GW-03-003	✓
	GW-03-004	✓
4	GW-04-001	✓
	GW-04-02BR	✓
	GW-04-003	✓
	GW-04-004	✓
5	GW-05-001	✓
6	GW-06-001	✓
	GW-06-002	✓
8	GW-08-001	✓
	GW-08-02BR	✓
10	GW-10-001	✓
	GW-10-002	✓
	GW-10-03BR	✓
	GW-10-004	✓
	GW-10-005	✓
	GW-10-006	✓
17	GW-17-001	
	GW-17-002	✓
	GW-17-003	✓
	GW-17-004	✓
	GW-17-005	
	GW-17-006	✓
	GW-17-007	
	GW-17-09BR	✓
	GW-17-10BR	✓
18	GW-18-001	✓
	GW-18-002	✓
	GW-18-003	✓
20	GW-20-01BR	✓
	GW-20-002	✓
	GW-20-03BR	✓

Table 3-17. Slug Tests Conducted in Monitoring Wells During Phase 1 Alabama Army Ammunition Plant, Childersburg, Alabama (Continued)

Study Area	Well Number	Slug Test Conducted
21	GW-21-01BR	✓
	GW-21-02BR	
BK	GW-BK-001	✓
	GW-BK-02BR	✓
7	P-12	✓
	P-52	✓
8	P-13	✓
	P-14	✓
27	P-50	✓
	P-51	✓

NOTES:

Total of 42 wells slug tested.
Total of 36 SAIC wells slug tested.
GW-20-002 was retested.

Prior to starting each slug test, the initial water level and total depth of the monitoring well were measured to the nearest 0.01 foot and were recorded in the field logbook. The Hermit data logger (model SE 1000C) was calibrated according to the manufacturer's instructions for slug tests with a logarithmic time scale in minutes and hours, and draw-down in feet. A pressure transducer (50 pounds per square inch [psi]) was lowered to between 0.1 and 2.4 feet from the bottom of the well. A decontaminated submersible pump with tubing was lowered into the well and positioned approximately 1 to 2 feet above the transducer. The water in the well was allowed to stabilize prior to initiating the slug test. Prior to initiating the slug removal, field personnel recorded the initial water level, stabilized water level, transducer depth, pump depth, data logger test number, and corresponding well number in a field logbook.

The well was purged until the water level was at the same depth as the pump intake. Purge water was containerized in 55-gallon drums. Simultaneously, the pump was turned off and the Hermit data logger was turned on to begin collecting recharge data. The depth to water was determined using the Hermit data logger and a water level indicator (WLI) while the test was running. After reaching 90 percent recharge, the Hermit program was terminated, the equipment was removed, and the wells were secured.

Data obtained during each slug test were stored on computer disk and the data were analyzed using curve matching techniques in the AQTESOLV® (Geraghty and Miller 1991) software package. An initial curve match was obtained using automatic, non-linear curve matching and the curves were adjusted manually. The data were analyzed using the Bouwer and

Rice (1976) and Cooper et al. (1973) analytical methods for unconfined or leaky confined aquifers. Hydraulic conductivity values were estimated from slug tests conducted at 42 monitoring wells associated with 12 RI sites. The results of the slug test analyses are provided in Section 4 and data plots for each test are provided in Appendix G.

3.7 ECOLOGICAL INVESTIGATIONS

Biological sampling of both aquatic and terrestrial biota and ecotoxicological bioassays were conducted during Phase 1 of the Supplemental RI at ALAAP. The primary goal of the ecological investigations was to gather site-specific data for use in the ecological risk assessment.

In addition, the sampling provided an indication of the overall health of the ecosystem that exists on ALAAP. The biological sampling also provided information for the human health risk assessment, to determine if human receptors are at risk from contact with contaminated terrestrial or aquatic plants and animals. During Phase 2 of the Supplemental RI, additional ecotoxicological bioassays were conducted based on the site-specific results and ecological chemicals of concern (ecoCOCs) identified during the Phase 1 investigation (SAIC 1996c). Additional refinement of the ecoRGOs was an objective of conducting the bioassays during Phase 2.

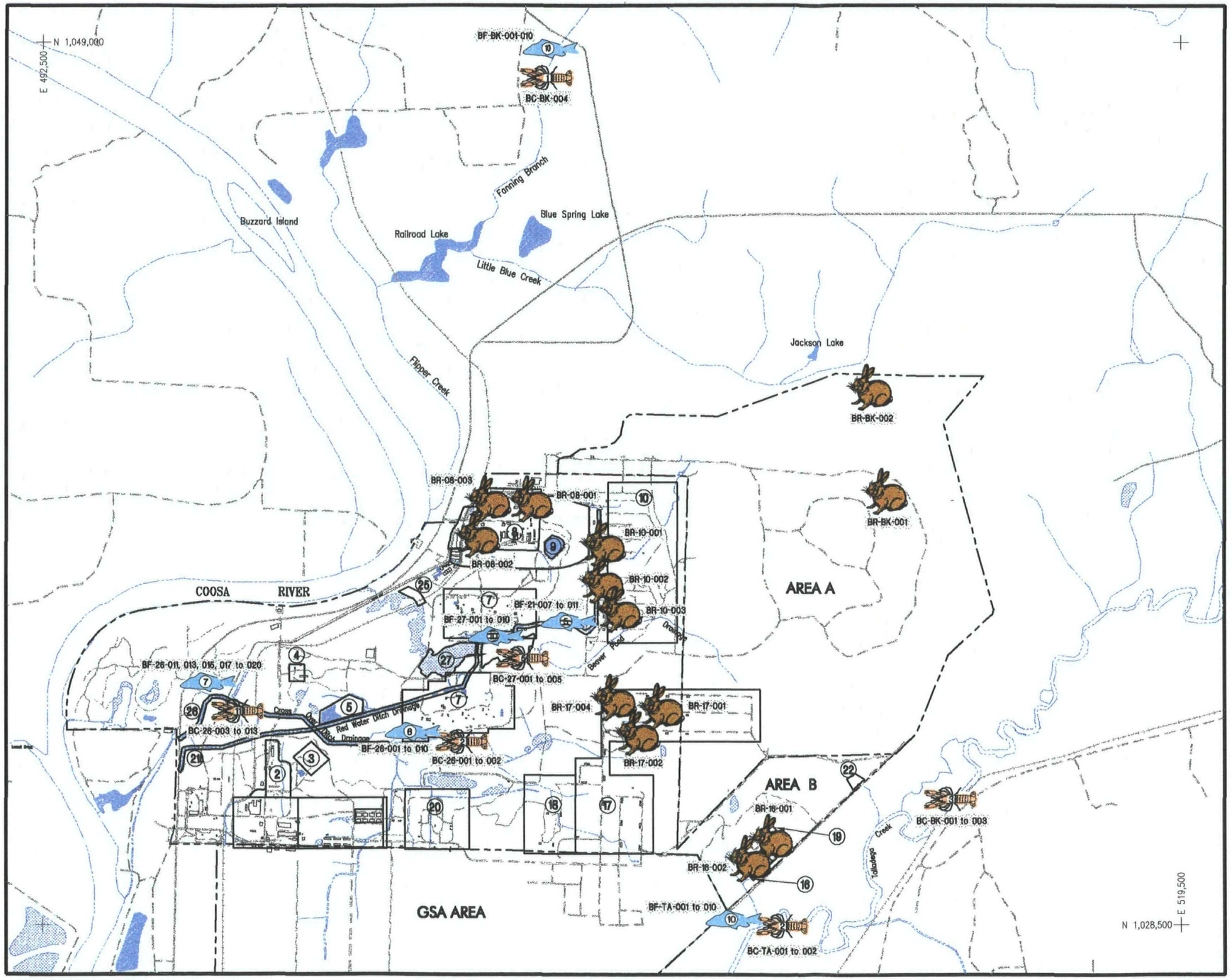
3.7.1 Aquatic Environment

This section summarizes the field methods used during the Phase 1 Supplemental RI to sample aquatic biological resources, including benthic macroinvertebrates, crayfish, and fish. The field standard operating procedures (SOPs) are detailed in the SAP/Work Plan (SAIC 1995a).

3.7.1.1 Benthic Macroinvertebrate Collection

Benthic macroinvertebrate sampling was conducted during Phase 1 of the Supplemental RI using ALAAP FTP-ALAAP-01, Benthic Macroinvertebrate Collection, as detailed in the SAP/Work Plan (SAIC 1995a). Benthic macroinvertebrate sampling was conducted from May 17 through 19, 1995. Samples were collected from a background location (Fanning Branch), Crossover Ditch (near SW03 and SW07), Red Water Ditch (near the elbow), the east Beaver Pond, and Talladega Creek. The sample locations are shown in **Figure 3-5**.

Organisms were collected using kicknets and then removed from the kicknets using stainless steel forceps. Once collected, the organisms were identified to their taxonomic family and preserved in labeled containers filled with 70 percent (v/v) ethanol. Preservation was conducted to archive the organisms for future examination or verification of identification.



LEGEND:

- PRIMARY ROADS
- SECONDARY ROADS
- TRAILS
- FENCE
- AREA BOUNDARIES
- (7) STUDY AREAS
- RAILROAD
- CREEK, TRIBUTARIES AND RIVER
- WETLANDS
- PONDS, IMPOUNDMENTS
- RABBIT COLLECTION LOCATION
- (10) FISH COLLECTION LOCATION
- (2) CRAYFISH COLLECTION LOCATION
- GRID BASED ON ALABAMA STATE PLANE EAST

NOTES:

1. BIOTA SAMPLES COLLECTED MAY THROUGH AUGUST 1995.
2. THE CIRCLED NUMBER ON EACH FISH AND CRAYFISH INDICATES MULTIPLE SAMPLES TAKEN AT GIVEN LOCATION.

STATE PLANE GRID

0 1250 2500 5000

SCALE: 1" = 2500'

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ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

Biota Sample Locations

Figure No.	Project No.	File Name	Date
3-5	01-0827-03-8178-045	99015\DWGS\E42BUNNY	03-31-99

3.7.1.2 Crayfish Sample Collection

Crayfish were collected during Phase 1 from June 15 through August 4, 1995, using ALAAP FTP-ALAAP-02, Crayfish Collection, as detailed in the SAP/Work Plan (SAIC 1995a). Crayfish were sampled from background locations (Fanning Branch and Talladega Creek near Kamauga Mill), Crossover Ditch (near SW03 and SW07), Red Water Ditch, the east Beaver Pond, and Talladega Creek (near SW24). The crayfish sampling locations corresponded to surface water sampling locations (see Figure 3-5).

Crayfish were collected using two live-capture techniques. The first technique used traps obtained from Memphis Net and Twine. The traps were approximately 12 by 12 by 18 inches and were constructed from wooden slats with a single entry. The traps were baited with chicken necks. Two different batches of chicken necks were used during the sampling. A 300-gram aliquot of each batch of chicken necks was wrapped in aluminum foil, bagged, labeled, frozen, and sent to the analytical laboratory for verification that they were not a potential source of contaminants via ingestion by the crayfish. At each sampling location, the traps were placed in the water within 10 feet of the stream bank. The traps were checked daily. At the completion of the sampling activities, the traps were removed from the creek and disassembled.

Because the traps in the background locations yielded no crayfish, the field team used a second live capture technique (i.e., hand captures) at the Kamauga Mill background site on Talladega Creek. Hand capture was not necessary at other sites because the crayfish traps provided enough organisms.

Immediately after capture, the crayfish were placed into a Ziploc® plastic bag and placed on ice in coolers. Upon return to the SAIC field office at ALAAP, the crayfish were rinsed with deionized (DI) water, rewrapped in fresh aluminum foil, bagged, labeled, and frozen at -20°C. At SAIC offices in Oak Ridge, Tennessee, individual tail muscle was excised from three frozen crayfish samples (approximately 6 to 8 grams each sample), rewrapped in fresh aluminum foil, bagged, labeled, and kept frozen at -20°C until and during shipment to the analytical laboratory. After the tail muscle had been excised, the remaining carcass was rewrapped in fresh aluminum foil, bagged, labeled, and kept frozen until and during shipment to the analytical laboratory. Crayfish tail muscle and body parts as well as whole-body crayfish from ALAAP – Area B were analyzed for pesticides/PCBs, SVOCs, explosives and explosive byproducts, and metals. Chemical analysis of all biological tissue was completed by EA Laboratories of Sparks, Maryland.

3.7.1.3 Fish Collection

Fish were collected during Phase 1 from May 17 through 24, 1995, using ALAAP FTP-ALAAP-03, Fish Collection, detailed in the SAP/Work Plan (SAIC 1995a). Fish were sampled at Fanning Branch (background), Crossover Ditch (at locations SW03 and SW07), Red Water Ditch, the east Beaver Pond, and Talladega Creek (see Figure 3-4). Fish were retrieved from streams and ponds using electroshocking. Backpack electroshockers were used at all locations

except Crossover Ditch near SW-07, the Beaver Ponds, and Talladega Creek, where a boat-mounted electroshocker was used. Boat-mounted electroshocking was used when the water bodies were too deep and/or voluminous to be sampled by personnel wearing backpack electroshocking equipment. Fish and Wildlife Associates, Inc., of Whittier, North Carolina, assisted with the boat-mounted electroshocking. Stunned fish were collected and kept in buckets containing water from the collection location until processing for analysis.

At each site, the objective was to obtain two fillet samples with their corresponding "remains" samples, in addition to two whole body samples and four composite whole body samples. Any fish that was deemed unsuitable for the analytical samples (e.g., too small or incorrect species) was released back to the location from which it was collected. Fillets were excised from the whole bodies at the SAIC field office at ALAAP. Fish that were selected for the analytical samples were wrapped in foil, placed in Ziploc® plastic bags, and frozen at -20°C until they were shipped to the analytical laboratory. Fish fillets, remains, and whole-body fish were analyzed for pesticides/PCBs, SVOCs, explosives and explosive byproducts, and metals.

3.7.2 Terrestrial Environment

This section discusses the method used during the Phase 1 Supplemental RI for collecting terrestrial biological samples. The field SOPs are detailed in the SAP/Work Plan (SAIC 1995a).

3.7.2.1 Small Game Collection

Rabbits were collected in June 1995, using ALAAP FTP-ALAAP-04, Small Game and Game Bird Collection, as detailed in the SAP/Work Plan (SAIC 1995a). The SAP specified that either quail, rabbits, or squirrels (in that order) could be collected for analysis. Game birds and squirrels were not collected during the study due to their low availability.

Rabbits were collected from a background location (northeast part of Area A) and at the Northern TNT Manufacturing Area (Study Area 7), Study Area 8, the Tetryl Manufacturing Area (Study Area 10) (western part), Study Area 17 (upper part), and Study Areas 16/19 using active and passive live capture techniques. The sample locations are shown in Figure 3-5. The active live capture method consisted of spotlight immobilization and netting. For this technique, a spotlight was used during the hours of darkness to locate and "immobilize" rabbits by shining the spotlight on them. Most of the temporarily immobilized rabbits were captured in nets, but a few were sacrificed with a headshot from a slingshot and stainless steel ball bearings. The passive live capture technique consisted of live-trapping using a Hava-Hart box trap. The live-traps were baited with fresh apple pieces. A total of 15 traps were placed in travel corridors, mostly along the edges of old and new roads. The traps were checked each morning and evening.

The captured rabbits were prepared in the field by cervical dislocation, stored in plastic bags, and then placed in ice-filled coolers. The prepared carcasses then were wrapped in aluminum foil, bagged, labeled, and placed into a locked freezer at approximately -20°C until they were

shipped to the analytical laboratory. Rabbit muscle was removed from the skeleton at the analytical laboratory, and the muscle was analyzed for pesticides/PCBs, SVOCs, explosives and explosive byproducts, and metals.

The analysis of tissue from rabbits, fish, and crayfish served two exposure purposes: they were analyzed for ingestion by humans and they were analyzed for ingestion by ecological receptors. Various chemicals bioaccumulate in such body locations as bones, kidneys, livers, hearts, and brains. However, the purpose of the contaminant body burden measurements was not to further document this fact, but rather to characterize those parts (muscle and whole body) eaten by receptors. In the case of human exposures, it was assumed that humans eat rabbit muscle, fish muscle (fillets), and crayfish. In the case of ecological receptors, it was assumed that receptors (and/or herons) ate rabbit muscle, whole body fish, an whole body crayfish. Thus, in some cases, not only the muscle but also the blood, bone, fat, and other body parts were analyzed chemically.

3.7.3 Rapid Bioassessment Protocol II

Benthic macroinvertebrate sampling initially was intended to be conducted using ALAAP FTP-ALAAP-05, Rapid Bioassessment Protocol (RBP) II, as detailed in the SAP/Work Plan (SAIC 1995a). RBP II can be used to prioritize sites for more intensive evaluation (e.g., RBP III, replicate sampling, and ambient toxicity testing). RBP II sampling utilizes the systematic field collection and analysis of major benthic taxa at the family taxonomic level. RBP II consists of a biosurvey component and an evaluation of water quality and habitat assessment for each sampling station, using standardized sampling techniques. The RBP II focuses on riffle/run habitat because it is the most productive habitat. RBP II also consists of the collection and evaluation of coarse particulate organic matter (CPOM) samples to measure effects from toxicants on the Shreders trophic component of the benthic community. Biological impairment of the benthic community can be indicated and measured by the following:

- Absence of generally pollution-sensitive taxa, such as Ephemeroptera, Plecopetra, and Trichoptera (EPT)
- Dominance by any particular tason, especially pollution-tolerant forms, such as Chironimidae and Oligochaeta
- Low overall number of taxa
- Major shifts in community composition relative to the reference site conditions.

On the basis of observations from the biosurvey, habitat assessment, and water quality, the investigator concludes whether impairment is detected.

Stream conditions at ALAAP during the benthic macroinvertebrate sampling were not conducive to performing the biosurvey component according to RBP II. For example, most of the

drainages or streams did not contain riffle areas, as expected, and CPOM samples were not successfully collected, which precluded using the RBP II biosurvey techniques. However, the benthic macroinvertebrate samples were collected successfully using ALAAP FTP-ALAAP-01, Benthic Macroinvertebrate Collection, as discussed in Section 3.7.1.1. In addition, water quality measurements were obtained along with the benthic macroinvertebrate samples.

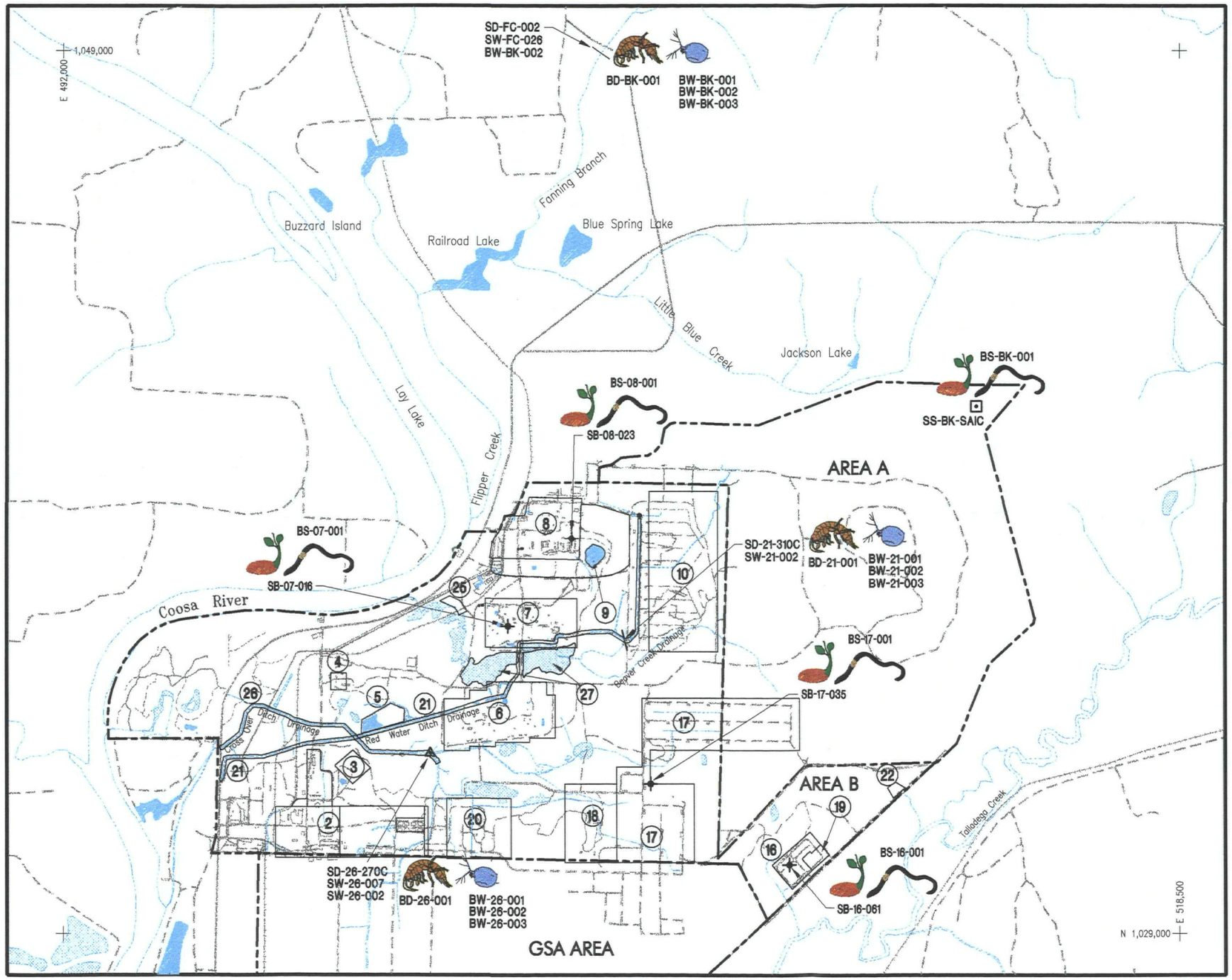
3.7.4 Bioassays

This section describes the methodologies for soil, sediment, and surface water media toxicity tests that were used for samples from ALAAP. The media toxicity tests were conducted by Toxicon Environmental Sciences of Jupiter, Florida, using standardized, approved methods. Media toxicity tests were conducted during the Phase 1 Supplemental RI in a two-staged approach (referred to as Stage I and Stage II). Stage I studies were conducted using undiluted sample media. Any samples that exhibited toxicity during the Stage I studies were subject to further testing in the Stage II investigation to confirm the presence of toxicity. Stage II studies involved repeating the toxicity tests with a newly collected sample from the station that was toxic during Stage I.

A range of site concentrations was included in the 1995 bioassays (when most bioassays were performed). The approach to the 1996 bioassays (when fewer bioassays were performed) was to identify the highest observed concentrations to increase the range of the 1995 data. Only a few abiotic measurements were available in 1995. Between the 1995 and 1996 bioassays, many more abiotic measurements were taken and, therefore, locations with high concentrations could be identified for the additional bioassays. This 2-year approach provided concentrations ranging from background or reference through intermediate to high.

Soil samples for the Stage I media toxicity studies were collected from ALAAP Study Areas 7, 8, 17, 16/19, and a background location on June 23, 1995. Sample locations are shown in **Figure 3-6**. Two types of soil toxicity tests were conducted, and each utilized a reference location soil and a control soil (artificial soil prepared by mixing, on a weight basis, 10 percent 2.36 mm-screened sphagnum peat, 20 percent colloidal kaolinite clay, and 70 percent silica sand). Earthworm toxicity tests were performed according to methods in *50 Federal Register (FR) 122*. The earthworm toxicity tests were 14-day exposures that measure survival of *Eisenia foetida* in bulk soil samples. The earthworms were not fed during the tests. The tests were considered acceptable if mean survival in the controls was ≥90 percent.

The second type of soil toxicity test that was used for samples from ALAAP was a 120-hour seed germination test that was conducted according to methods in *50 FR 188*. The seed germination test used the herbaceous winter annual, *Arabidopsis thaliana*, and measures the number of germinated seed in bulk soil samples. An acceptable test is obtained when mean germination in the control soils is ≥90 percent. Stage II tests were not required because no toxicity was observed during the Stage I soil toxicity tests.



LEGEND:

- BUILDINGS
- PRIMARY ROADS
- SECONDARY ROADS
- TRAILS
- FENCE
- AREA BOUNDARIES
- STUDY AREAS
- RAILROAD
- CREEK, TRIBUTARIES AND RIVER
- WETLANDS
- PONDS, IMPOUNDMENTS
- SW-FC-002 . . . . . SURFACE WATER SAMPLE FOR BIOASSAY
- SB-08-023 . . . . . SOIL BORING SAMPLE FOR BIOASSAY
- SS-BK-SAIC . . . . . SURFACE SOIL SAMPLE FOR BIOASSAY
- SD-FC-002 . . . . . SEDIMENT SAMPLE FOR BIOASSAY
- CERIODAPHNIA
- HYALLELLA
- GERMINATING SEED
- EARTHWORM
- GRID BASED ON ALABAMA STATE PLANE EAST

STATE PLANE GRID

0 1250 2500 5000

SCALE: 1" = 2500'

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ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

Bioassay Sample Locations
June 1995

Figure No.	Project No.	File Name	Date
3-6	01-0827-03-8178-045	99015\DWGS\E42SEED	03-31-99

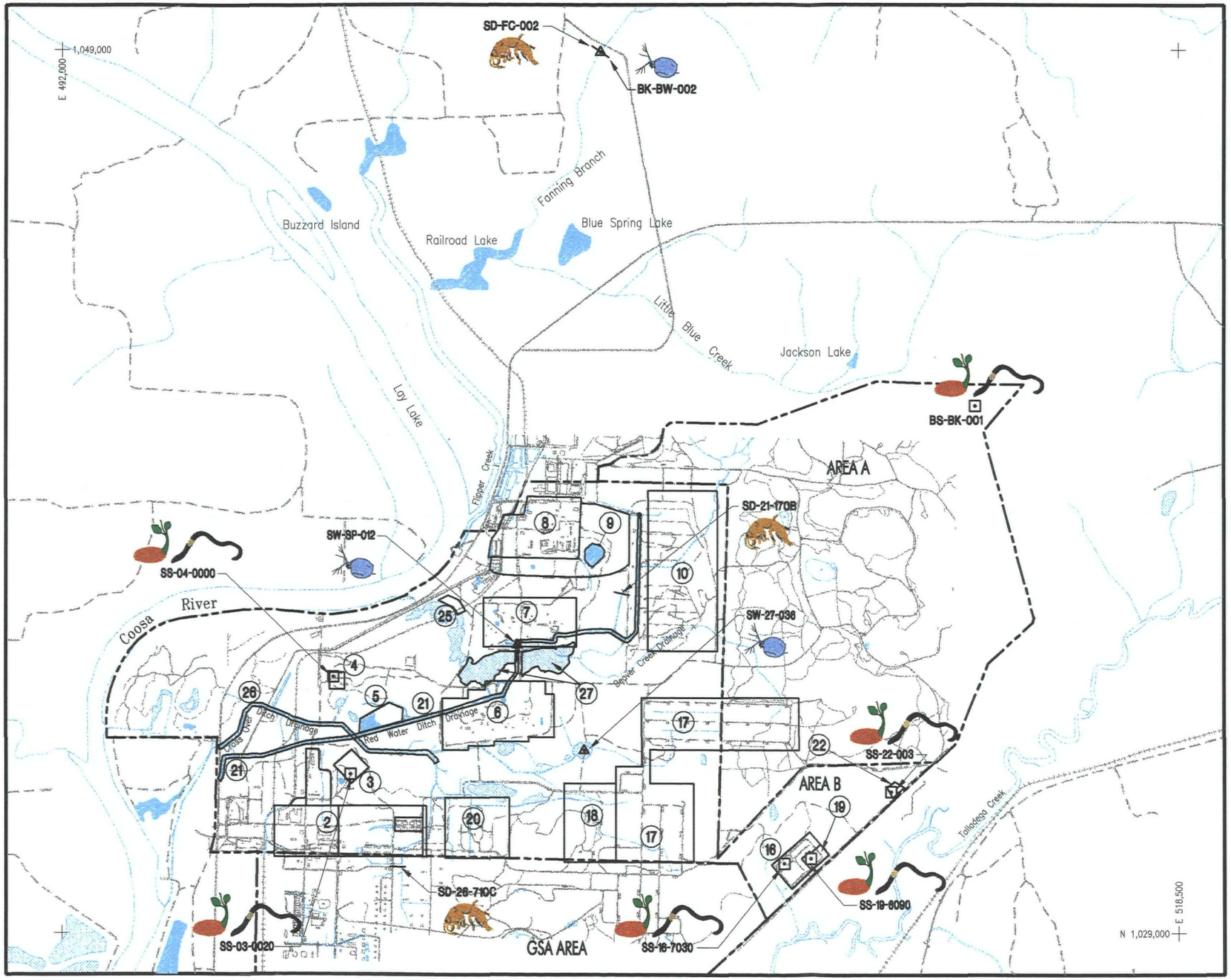
Sediment samples for the Phase 1 Stage I studies were collected from ALAAP Study Areas 21 and 26, and a background location on June 22, 1995 (see Figure 3-5). The media toxicity tests were conducted according to American Society for Testing Materials (ASTM) Method 1383-A1 (ASTM 1994). The toxicity test used bulk sediment and a 10-day exposure that measures survival of the amphipod, *Hyalella azteca.*

Sediment samples for the Phase 1 Stage II studies were collected from the same two locations at ALAAP (in addition to the background location) that were sampled during Stage I. The samples for Stage II were collected on August 2, 1995. The media toxicity tests for Stage II were the same as those performed for Stage I. During the Stage II sampling, surface water was no longer present at Study Area 21, so the sediment samples from this area were collected from the dry ditch. Potential effects of the use of "dried" sediment during Stage II versus inundated sediment during Stage I is discussed in Section 7.

During the Phase 1 investigation, surface water samples for the Stage I studies were collected from ALAAP Study Areas 21 and 26, as well as a reference location from June 19 through 23, 1995 (see Figure 3-5). The surface water toxicity tests were conducted using two different test organisms according to EPA methods. Both methods are considered short-term tests to estimate chronic toxicity (EPA 1991d). Method 1002.0 uses *Ceriodaphnia dubia* in a three-brood, static test with daily renewal that measures survival and reproduction as the test endpoints. A control test for the *Ceriodaphnia* is obtained when: (1) at least 60 percent of surviving females in the controls produce three broods, and (2) there is ≥80 percent survival and an average of ≥15 young per surviving female in the controls. Stage II studies were not required because toxicity was not observed during Stage I.

The results of the media toxicity tests were used in the development of ecoRGOs following the Phase 1 investigation (SAIC 1996c). Because the ecoCOCs and the maximum concentrations of ecoCOCs were not available when the bioassays were conducted (during the Phase 1 investigation), it was determined that additional refinement of the ecoRGOs would be beneficial. During the Phase 2 investigation, additional media toxicity tests were conducted using media that contained the maximum concentrations of ecoCOCs or the greatest number of ecoCOCs at concentrations near the maximum. The tests were conducted for the media-specific ecoCOCs identified following the Phase 1 investigation. Only Stage 1 testing was performed. Soil, sediment, and surface water media toxicity tests were conducted by Toxicon Environmental Sciences of Jupiter, Florida, using the same standardized, approved methods as described previously.

Seven soil toxicity tests were conducted during the Phase 2 investigation (June 1996) at the following locations: SS-04-0000, SS-03-0020, SS-19-6090, SS-16-7030, and SS-22-003. One duplicate was collected at location SS-04-0000 and a reference sample was collected at location BS-BK-001. The locations where soil media were collected for the toxicity tests are shown in **Figure 3-7**.



LEGEND:

- BUILDINGS
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- PONDS, IMPOUNDMENTS
- BK-BW-002 ..... SURFACE WATER SAMPLE FOR BIOASSAY
- BS-BK-001 ..... SURFACE SOIL SAMPLE FOR BIOASSAY
- SD-FC-002 ..... SEDIMENT SAMPLE FOR BIOASSAY
- CERIODAPHNIA
- HYALLELLA
- GERMINATING SEED
- EARTHWORM
- GRID BASED ON ALABAMA STATE PLANE EAST

STATE PLANE GRID

0 1250 2500 5000

SCALE: 1" = 2500'

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CHILDERSBURG, ALABAMA

Bioassay Sample Locations
June 1996

Figure No.	Project No.	File Name	Date
3-7	01-0827-03-8178-045	99015/DWGS/E42BIO	03-31-99

Soil samples were collected on June 4, 1996 from these locations, sent to the analytical laboratory (QST, formerly ESE), and analyzed for aluminum and lead concentrations. These analyses were conducted prior to performing the media toxicity tests to ensure that the media contained concentrations of ecoCOCs for soil (e.g., aluminum and lead) that were greater than the ecoRGOs. Once the concentrations of ecoCOCs for soils (e.g., aluminum and lead) were confirmed, a sufficient volume of soil was collected from the locations to conduct the soil toxicity tests.

Soil samples were collected on June 26, 1996 and two types of soil toxicity tests were performed; these included earthworm toxicity tests and 120-hour seed germination tests. Both tests were conducted as described for the Phase 1 toxicity tests.

During the Phase 2 investigation, five sediment toxicity tests were conducted at the following locations: SD-21-170B, SD-26-710C, SD-27-030C, a duplicate at SD-21-170B, and a reference location SD-FC-002. The locations where sediment media were collected for the toxicity tests conducted during the Phase 2 investigation are shown in Figure 3-7.

Sediment samples were collected on June 5, 1996 and analyzed for aluminum, arsenic, iron, lead, and mercury. These metals were the ecoCOCs identified in sediments as a result of the Phase 1 investigations (SAIC 1996c).

After the concentrations of ecoCOCs were confirmed, a sufficient volume of sediment was collected for the toxicity tests on June 27, 1996. The toxicity test was conducted using a 10-day exposure that measures survival of the amphipod, *Hyalella azteca*.

Five surface water toxicity tests were conducted during the Phase 2 investigation at the following locations: SW-21-004, SW-SP-012, SW-27-037, a duplicate at SW-SP-012, and a reference location BK-BW-002. The locations where the surface water media were collected for the toxicity tests are shown in Figure 3-7.

Surface water samples were collected on June 4, 1996 and analyzed for barium, iron, and manganese. These metals were the ecoCOCs identified in surface water during the Phase 1 investigations (SAIC 1996c).

The concentrations of ecoCOCs were confirmed at each selected location and a sufficient volume of surface water was collected for the toxicity tests on June 26, 1996. The toxicity test performed for surface water used *Ceriodaphnia dubia* in a three-brood, static environment with daily renewals of surface water.

3.8 INVESTIGATION-DERIVED WASTE

Waste generated during field work at ALAAP included sanitary waste, drill cuttings from soil borings and monitoring wells, water from well development and purging activities,

decontamination wastes, and wastes derived from the field screening laboratory. The management of these wastes generally followed procedures described in Section 5.4 of the SAP/Work Plan (SAIC 1995a). The following sections summarize the wastes produced and the methods used for their management and disposal.

3.8.1 Sanitary Wastes

Sanitary wastes included items such as used plastic, foil, personal protective equipment (PPE), shipping containers (cardboard boxes), and paper towels. As directed by the facility coordinator, sanitary wastes were collected in plastic trash bags and initially disposed of at the ALAAP dump near Study Area 3. On April 26, 1995, SAIC was informed that the dump no longer could be used for disposal because of remedial activities being conducted in that area by Roy F. Weston, Inc. As a result, SAIC contracted Waste Management, Inc. to provide trash hauling and disposal services. After April 26, 1995, all sanitary wastes were placed in the dumpster and disposed of by Waste Management, Inc. via an onsite dumpster.

3.8.2 Drill Cuttings

Drill cuttings were generated from soil borings completed for subsurface soil sampling (i.e., soil borings) and monitoring well installation (i.e., well borings). At each boring location, drill cuttings were placed on and covered with plastic sheeting pending the outcome of analytical results. Cuttings at soil boring locations were characterized based on analytical data from the associated soil samples. Because samples were not collected during monitoring well drilling and installation, samples from drill cuttings were collected from each monitoring well location and composited with samples collected at monitoring well locations within their respective study areas. Samples were collected in this manner to characterize soil at well locations within each study area. Composite samples from each study area were submitted for TCLP extraction and analysis to evaluate whether soil cuttings at well locations should be disposed of as hazardous or nonhazardous waste.

Soil samples were collected and composited at 11 study areas during the Phase 1 activities. One composite sample was submitted from each study area for TCLP analysis. Soil samples were analyzed for TCLP VOCs, TCLP SVOCs, TCLP metals, TCLP pesticides, and TCLP herbicides, and were analyzed in accordance with EPA SW 846 TCLP procedures. Analytical results indicated that composite samples from each study area did not exhibit toxicity characteristics. Soil piles at well and soil boring locations were considered nonhazardous based on TCLP results, analytical data from soil borings, and previous generator knowledge.

During Phases 2 and 3 of the Supplemental RI, soil cuttings generated from soil boring and monitoring well drilling were spread over the ground at the study area based on generator knowledge of soils. Generator knowledge included Phase 1 analytical results and analytical (Phases 2 and 3) and field screening (Phase 2) results from collected soil samples.

3.8.3 Development/Purge Water

Groundwater from development and purging activities during Phases 1 and 2 was containerized in U.S. Department of Transportation (DOT)-approved, 55-gallon drums. Periodically, during the field investigation, drummed groundwater was pumped into 1,050-gallon polyethylene tanks and transferred to a permitted onsite treatment facility (TIS-20) managed by Roy F. Weston. All development and purge water generated during the Phase 1 and Phase 2 investigations was disposed of in this manner.

The development and purge water collected during the Phase 3 investigation was containerized in U.S. DOT-approved drums. Analytical results from groundwater collected from the monitoring wells sampled were reviewed and compared to RGOs developed by SAIC for human exposure under a residential land use scenario (SAIC 1996c). Groundwater that contained concentrations of constituents less than the RGOs was surface discharged. Groundwater that contained concentrations that exceeded the RGOs was transferred to 1,050-gallon polyethylene tanks, transported to the onsite treatment facility (TIS-20) managed by Roy F. Weston, and treated by carbon filtration. This treatment took place from October 6 through 8, 1997.

3.8.4 Decontamination Wastes

Sampling and drilling equipment decontamination processes and well development and sampling resulted in the generation of liquid and solid wastes. The liquids and solids were segregated and temporarily stored onsite in DOT-approved, 55-gallon drums. At the end of the investigation, the decontamination well development and sample liquids were pumped into 1,050-gallon polyethylene tanks and transferred to the permitted onsite treatment facility (TIS-20) managed by Roy F. Weston.

One composite sample was collected from drums staged at the decontamination area. Contents of the drums at the decontamination pad consisted of soil from study areas mixed with water and LIQUI-NOX® generated from decontaminating field equipment. Composite samples were sent to a contracted laboratory for TCLP analysis. Soil samples were analyzed for TCLP VOCs, TCLP SVOCs, TCLP metals, TCLP pesticides, and TCLP herbicides, and were analyzed in accordance with EPA SW 846 TCLP procedures. Analytical results indicated that composite samples from decontamination did not exhibit characteristics of toxicity. Soils drummed from decontamination procedures were considered nonhazardous due to the results above and previous generator knowledge. SAIC contracted Laidlaw Environmental Services of Greenbriar, Tennessee, to transport nonhazardous waste to an offsite permitted landfill.

3.8.5 Acetone Wastes and Acetone Contaminated Soil

Field laboratory procedures resulted in the generation of limited quantities of RCRA hazardous waste that included (liquid) acetone waste and acetone contaminated soil. During the Phase 1 and Phase 2 field investigations, these wastes were segregated and contained in lined, DOT-approved, 55-gallon drums. Drums were staged onsite within a posted, bermed, and plastic

lined exclusion area. A total of approximately 30 gallons of waste liquid acetone and 40 gallons of acetone contaminated soil were generated during the field investigation activities. SAIC contracted Laidlaw Environmental Services of Greenbriar, Tennessee to package, manifest, transport, and arrange for treatment and/or ultimate disposal of the wastes at an offsite permitted facility in accordance with all applicable DOT and RCRA requirements. Shipping manifests for the wastes were signed by an authorized agent of the U.S. Army. No RCRA hazardous wastes were generated during the Phase 3 investigation.

3.8.6 Unused Sample Soil and Sediment

Soil and sediment sample portions that were not used in field screening or sent to the analytical laboratory were stored onsite in DOT-approved, 55-gallon drums. Two 55-gallon drums of unused soil/sediment were collected during Phases 1 and 2 of the field investigation. To characterize these soils, one sample was composited along the entire depth of each drum and analyzed for TCLP characteristics.

One composite sample was collected from each drum and sent to a contracted laboratory for TCLP analysis. Soil samples were analyzed for TCLP VOCs, TCLP SVOCs, TCLP metals, TCLP pesticides, and TCLP herbicides, and analyzed in accordance with EPA SW 846 TCLP procedures. Analytical results indicated that composite samples from each drum did not exhibit characteristics of toxicity. Unused soils were considered nonhazardous due to the results above and previous generator knowledge and spread on the ground onsite.

3.9 BACKGROUND SAMPLING

Background samples for surface (0 to 1 foot BLS) and subsurface (1 to 10 feet BLS) soil, sediment, surface water, groundwater, and biota were collected to establish a baseline for the determination of site-related contamination and risk assessment.

Background soil boring locations were located in the east-southeast corner of Area B. Background soil boring locations were selected in a location upgradient and isolated from past plant activities. Soil samples were collected for a full suite of contaminants. Additional soil background data were obtained from a study conducted for Area A (ESE 1995) in which 20 surface soil locations were sampled east of Area A.

Background groundwater samples were collected to establish a baseline for comparing environmental samples collected in Area B and assess background concentrations of metals. Groundwater from the newly installed (GW-BK-001 and GW-BK-02BR) and existing (P-84 and D-20) background wells was sampled for explosives and their byproducts, VOCs, SVOCs, metals, TOC, and pesticides/PCBs. Hexavalent chromium was analyzed only in the shallow well (GW-BK-001).

Background surface water, sediment, and aquatic organism samples were obtained from creeks surrounding ALAAP, including Fanning and Talladega Creeks.

4. RESULTS OF FIELD INVESTIGATIONS

This section provides the results of the field investigations and analysis of samples collected by Science Applications International Corporation (SAIC) during the Supplemental Remedial Investigation (RI) at the Alabama Army Ammunition Plant (ALAAP). The field investigations conducted at Area B of ALAAP included site-specific geologic and hydrogeologic measurements and observations and quantitative and semi-quantitative sampling and analysis of surface soil, subsurface soil, surface water, groundwater, sediment, and biological tissue. The results of these investigations are provided in the following sections. The spatial distribution of representative chemical constituents with respect to the known site areas was assessed to identify potential source areas for detected compounds.

4.1 SITE GEOLOGY AND HYDROGEOLOGY

Geologic and hydrogeologic conditions underlying ALAAP have been investigated by soil sampling, rock coring, groundwater and surface water elevation measurement, and aquifer (slug) testing. Previous hydrogeologic investigations conducted by Environmental Science and Engineering (ESE) between 1981 and 1994 provided the basis for the additional work completed under the present investigation. The previous site characterizations were supplemented by an additional 61 monitoring wells and 77 soil borings during the present study. Drilling records and well construction diagrams for the wells and borings installed during the Supplemental RI are provided in Appendices D and E. Ground surface and top of casing elevation measurements were obtained at existing and new monitoring well locations (see **Table 4-1**).

4.1.1 Topographic Mapping Results

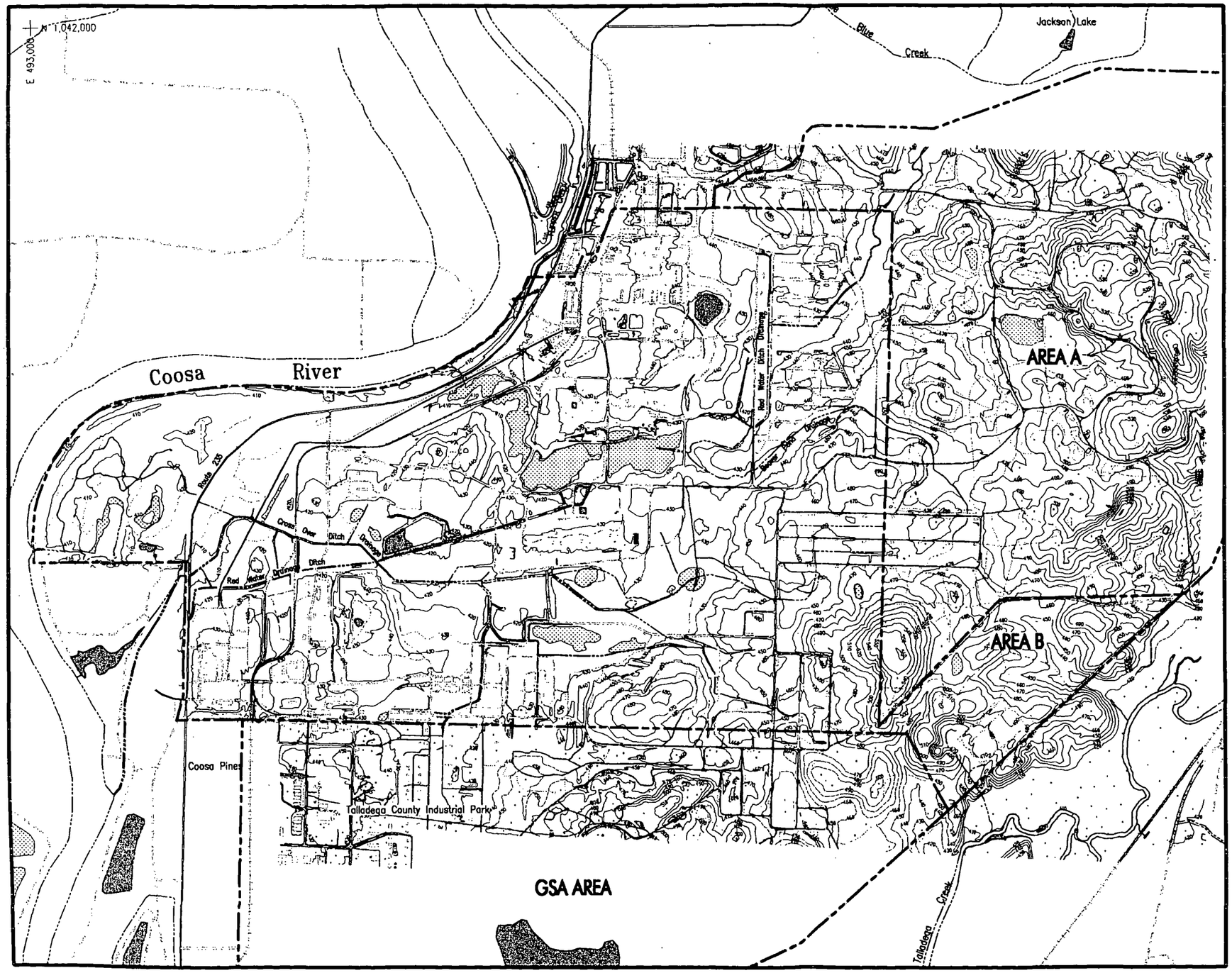
The surface topography in Area B was mapped using aerial photography taken over ALAAP in February 1995 (see **Figure 4-1**) by Air Survey Corporation of Sterling, Virginia. Image rectification and photogrammetric measurements from the photography also were made by Air Survey Corporation. Spot elevations measured from the photography ranged from 402.5 to 559.4 feet above mean sea level (msl) with an average elevation of 433.3 feet above msl. The topography is broadly undulating across the majority of Area B and increases to 440 feet above msl along the eastern boundary in the vicinity of the Tetryl Manufacturing Area (Study Area 10), Propellant Shipping Area (Study Area 17), and Blending Tower Area (Study Area 18). The highest elevations (499.8 to 553 feet above msl) occur in the vicinity of the Flashing Ground (Study Area 16) and Lead Facility (Study Area 19), and the highest elevation (559.4 feet above msl) occurs northeast of Study Area 16. The surface topography is interrupted by man-made drainage trenches and naturally developed erosional valleys, particularly in the eastern and southeastern portions of Area B. A well-developed sinkhole feature measuring approximately 225 feet in diameter occurs immediately to the west of Study Area 16.

Table 4-1. Monitoring Well Survey Data - Alabama Army Ammunition Plant

Well	Alabama SPC (NAD 1983) East	Alabama SPC (NAD 1983) North	Top of Casing Elevation	Source
C-2*	504258.92	1036930.42	437.21	ES&E
C-3A	504720.38	1037344.81	440.66	ES&E
C-3B	504713.68	1037337.28	441.32	ES&E
C-3C	504719.94	1037336.25	441.94	ES&E
D-1*	501003.99	1034058.44	431.01	ES&E
D-2	501684.92	1036082.63	428.76	ES&E
D-3	503159.26	1036083.90	433.53	ES&E
D-4	504126.52	1034251.20	433.5	ES&E
D-5*	502522.30	1033005.93	425.71	ES&E
D-6	500993.36	1032857.91	425.25	ES&E
D-7B	501475.91	1035093.81	423.03	ES&E
D-8*	500901.82	1033559.28	427.22	ES&E
D-9	500053.25	1033387.72	422.38	ES&E
D-10	499617.02	1034476.17	433.59	ES&E
D-11	500085.19	1035438.24	423.27	ES&E
D-12	501195.64	1036445.39	424.26	ES&E
D-13	505991.84	1038609.21	441.4	ES&E
D-14	507376.49	1036942.72	460.48	ES&E
D-15	505002.83	1031811.48	453.44	ES&E
D-16	508912.62	1029697.78	471.16	ES&E
D-17	508339.47	1030498.75	516.37	ES&E
D-18	509739.25	1031445.67	467.78	ES&E
D-19	509769.38	1030323.74	487.98	ES&E
D-20	515996.78	1039880.51	536.76	ES&E
D-21	510618.65	1040467.98	480.59	ES&E
D-22	509984.17	1041745.11	475.34	ES&E
D-23	513121.82	1041266.45	481.26	ES&E
P-1*	497253.05	1026923.61	426.88	ES&E
P-2*	498651.05	1026009.61	432.37	ES&E
P-3*	499750.14	1030062.73	425.56	ES&E
P-4	498351.43	1032822.38	426.28	ES&E
P-5	498436.22	1034256.79	428.05	ES&E
P-6*	498951.05	1033018.61	418.1	ES&E
P-7	499007.60	1033472.30	422.26	ES&E
P-8	500043.03	1033400.13	423.15	ES&E
P-9*	502521.05	1033073.61	426.48	ES&E
P-10	502388.19	1033719.82	428.27	ES&E
P-11	502505.54	1035255.98	424.98	ES&E
P-12	502822.38	1036160.17	431.8	ES&E
P-13	502798.05	1037400.61	432.55	ES&E
P-14	503354.27	1037921.55	436.87	ES&E
P-15	504063.76	1037046.99	445.22	ES&E
P-16	504005.05	1037618.61	443.55	ES&E
P-17	504464.59	1036903.44	439.98	ES&E
P-18	504709.53	1037330.81	441.48	ES&E
P-19	505489.05	1035229.61	439.25	ES&E
P-20	507007.05	1035874.61	443.05	ES&E
P-21	511131.39	1035793.53	494.79	ES&E
P-22	510482.28	1040253.94	479.34	ES&E
P-23	511184.05	1041498.61	467.64	ES&E
P-24	513576.05	1037109.61	473.65	ES&E
P-25	509699.06	1030251.55	491.99	ES&E
P-26	508987.74	1029632.09	471.3	ES&E
P-27	509022.40	1029413.87	458.79	ES&E
P-28	509249.16	1030630.29	495.18	ES&E
P-29	508735.49	1029870.82	471.09	ES&E
P-30	505005.26	1031776.42	454.35	ES&E
P-31	499581.83	1033913.82	426.6	ES&E
P-32	500457.15	1033428.09	421.59	ES&E
P-35	501351.78	1033771.73	423.78	ES&E
P-36	502091.80	1033875.97	427.43	ES&E
P-37	502879.37	1033821.51	427.45	ES&E
P-39	501995.70	1035193.65	432.38	ES&E
P-41	503376.44	1035314.62	425.93	ES&E
P-42	503947.46	1036928.82	448.88	ES&E
P-44	505153.07	1034985.64	435.05	ES&E
P-46	506042.18	1035472.47	435.91	ES&E
P-48	509082.33	1029354.36	434.25	ES&E
P-49	500934.10	1033930.42	430.01	ES&E
P-50	501153.49	1034417.97	420.06	ES&E
P-51	501405.85	1034797.54	420.36	ES&E
P-52	501534.88	1035329.68	423.42	ES&E
P-53	501604.65	1035921.52	431.84	ES&E
P-54	513446.04	1036921.36	485.57	ES&E
P-55	514540.33	1036067.77	480.85	ES&E
P-56	514286.53	1037041.00	482.85	ES&E
P-57	510631.81	1040458.29	480.01	ES&E
P-58	510240.92	1040434.88	495.75	ES&E
P-59	510242.34	1040054.83	510.73	ES&E
P-60	497808.46	1033090.17	415.7	ES&E
P-61	500011.20	1035887.33	420.07	ES&E
P-62	499601.52	1034425.91	431.14	ES&E
P-63	500064.94	1035425.63	422.43	ES&E
P-64	501217.52	1036455.75	424	ES&E
P-65	505969.25	1038570.79	441.3	ES&E
P-66	507398.89	1036929.50	459.65	ES&E
P-67	505011.84	1031769.32	452.1	ES&E
P-68	508971.23	1029636.49	471.18	ES&E
P-69	508325.83	1030520.48	518.41	ES&E
P-70	509692.58	1031384.93	470.31	ES&E
P-71	509802.86	1030314.41	488.06	ES&E
P-72	511453.04	1041202.88	469.15	ES&E
P-73	510215.95	1040988.89	468.04	ES&E
P-74	509852.63	1038922.51	462.76	ES&E
P-75	510847.89	1036477.93	475.47	ES&E
P-76	513997.23	1036448.37	459.16	ES&E
P-77	513343.53	1034291.02	450.91	ES&E
P-78	505750.50	1039738.39	471.99	ES&E
P-79	507734.28	1037397.26	457.78	ES&E
P-80	507686.33	1037086.73	474	ES&E
P-81	507823.03	1036826.79	465.54	ES&E
P-82	508330.56	1032861.38	475.36	ES&E
P-83	508721.40	1031777.55	479.56	ES&E
P-84	515776.64	1041104.54	526.54	ES&E
P-85	509999.58	1041754.63	475.36	ES&E
P-86	511863.31	1042225.91	470.24	ES&E
P-87	508927.25	1040634.14	453.99	ES&E
P-88	510860.45	1040031.10	493.18	ES&E
P-89	511171.51	1040833.93	518.26	ES&E
P-90	505989.92	1039313.25	450.32	ES&E
P-91	505536.84	1040400.95	473.76	ES&E
GW-BK-001	512226.16	1032374.33	437.06	SAIC
GW-BK-02BR	512241.66	1032388.35	437.66	SAIC
GW-02-001	496488.03	1030888.44	433.59	SAIC
GW-02-002	498301.05	1031504.63	449.36	SAIC
GW-02-003	498993.05	1030385.70	424.63	SAIC
GW-02-005	497498.37	1030471.70	438.54	SAIC
GW-03-001	498876.86	1032717.36	423.65	SAIC
GW-03-002	498786.95	1031790.04	449.5	SAIC
GW-03-003	498379.12	1031746.72	454.96	SAIC
GW-03-004	498042.24	1032846.15	420.74	SAIC
GW-04-001	495715.69	1031975.61	427.54	SAIC
GW-04-02BR	497461.20	1034983.83	420.95	SAIC
GW-04-003	498173.68	1034445.75	418.68	SAIC
GW-04-004	498653.05	1034617.68	418.68	SAIC
GW-04-005BR	499054.76	1035396.20	420.77	SAIC
GW-04-006BR	498255.93	1035013.80	419.98	SAIC
GW-05-001	497490.00	1034998.75	421.67	SAIC
GW-06-001	502181.46	1037792.12	427.6	SAIC
GW-06-002	500682.06	1032951.72	426.23	SAIC
GW-08-001	503726.80	1038550.28	437.58	SAIC
GW-08-002BR	502193.23	1037804.37	427.92	SAIC
GW-10-001	506907.74	1037972.63	434.92	SAIC
GW-10-002	505167.90	1038226.84	436.99	SAIC
GW-10-003BR	505160.72	1036821.48	432.88	SAIC
GW-10-004	505175.51	1035702.11	425.92	SAIC
GW-10-005	504227.39	1036127.52	435.71	SAIC
GW-10-006	505163.36	1036846.49	433.19	SAIC
GW-16-002	507686.29	1030102.90	470.352	SAIC
GW-16-003	508422.76	1030015.00	458.25	SAIC
GW-16-005	508034.11	1030406.20	495.04	SAIC
GW-16-006	508179.25	1029214.70	447.65	SAIC
GW-16-007	509003.75	1029401.20	457.63	SAIC
GW-16-008BR	510682.17	1031060.20	429.13	SAIC
GW-16-009BR	509285.77	1029665.00	475.48	SAIC
GW-17-001	507112.61	1033835.42	466.04	SAIC
GW-17-002	508927.24	1033284.70	469.42	SAIC
GW-17-003	506371.43	1032658.89	458.66	SAIC
GW-17-004	505536.14	1033570.19	463.33	SAIC
GW-17-005	505558.22	1031509.09	498.62	SAIC
GW-17-006	505913.67	1030566.19	460.02	SAIC
GW-17-007	507277.31	1032289.58	499.49	SAIC
GW-17-009BR	507067.89	1033835.84	466.72	SAIC
GW-17-010BR	506513.92	1031527.53	497.1	SAIC
GW-17-011	507067.89	1033801.30	465.68	SAIC
GW-17-012	505512.01	1032659.30	455.25	SAIC
GW-17-013	507260.32	1032398.00	491.38	SAIC
GW-17-014	507381.26	1030825.00	535.01	SAIC
GW-17-015	506414.98	1030851.10	470.2	SAIC
GW-17-016	506853.44	1030150.50	488.1	SAIC
GW-17-018	503893.70	1033476.60	431.98	SAIC
GW-17-019	505685.22	1034187.80	456.1	SAIC
GW-17-020BR	505375.82	1031745.50	454.5	SAIC
GW-17-021BR	504264.11	1033135.70	425.57	SAIC
GW-18-001	504589.65	1030462.76	442.49	SAIC
GW-18-002	503659.04	1031794.63	428.3	SAIC
GW-18-003	502659.05	1031215.72	432.86	SAIC
GW-18-005	503451.82	1030205.30	472.22	SAIC
GW-18-006	502154.99	1030369.80	48.18	SAIC
GW-18-007	501777.89	1032000.60	424.91	SAIC
GW-18-008BR	503966.28	1031776.70	431.18	SAIC
GW-18-009BR	504503.30	1030170.80	446.94	SAIC
GW-20-001BR	502632.86	1031160.64	436.81	SAIC
GW-20-002	500409.84	1031571.70	424.04	SAIC
GW-20-003BR	500414.99	1031619.83	423.44	SAIC
GW-21-001BR	495688.93	1031983.88	427.4	SAIC
GW-21-002	496555.59	1030910.34	433.54	SAIC
SG-1	501447.02	1034712.99	413.31	Staff gauge
SG-2	501896.21	1034284.6	414.34	Staff gauge
SG-3	502756.35	1034981.16	417.04	Staff gauge
SG-4	502692.97	1034735.67	418.89	Staff gauge
SG-5	505108.61	1035278.7	423.59	Staff gauge
SG-6	500301.49	1035939.31	399.67	Staff gauge
SG-7	500606.32	1031655.68	420.77	Staff gauge
SG-8	501632.12	1032795.66	420.22	Staff gauge
SG-9	497837.67	1032911	416.07	Staff gauge
SG-10	507046.21	1037934.82	434.87	Staff gauge
SG-11	504563.66	1049143.64	413.61	Staff gauge
SG-12	495680	1032783.28	407.89	Staff gauge
ASH-2*	502115.04	1024793.63	DNP	KC
ASH-4*	500636.14	1026793.73	DNP	KC
MW-1*	505474.03	1028520.98	461.11	KC
MW-1S*	501961.94	1028782.23	476.28	KC
MW-2*	504307.5	1028866.34	498.66	KC
MW-2S*	501761.94	1028565.23	476.83	KC
MW-3*	504596.72	1027776.66	469.53	KC
MW-3S*	501841.14	1028548.53	478.53	KC
MW-4*	505582.22	1027777.16	523.88	KC
MW-4S*	501718.64	1028642.33	475.75	KC
MW-5*	507293.94	1027985.47	459.79	KC
MW-5S*	501907.84	1028723.93	477.52	KC
MW-6*	503046.57	1025724.85	452.04	KC
MW-6S*	501816.14	1028621.43	478.21	KC
MW-7*	504467.83	1025932.75	417.73	KC
MW-7S*	501753.64	1028675.63	477.75	KC
MW-8*	504079.08	1025712.97	414.27	KC
MW-8S*	501761.94	1028608.93	478.22	KC
MW-9*	502902.63	1025377.11	449.85	KC
MW-9S*	501774.44	1028633.93	479.09	KC
MW-10S*	501549.54	1028496.43	468.33	KC
MW-11S*	502028.64	1029121.43	461.19	KC
MW-12S*	501153.64	1028542.33	467.83	KC
MW-13S*	501766.14	1028627.69	479.21	KC
MW-14S*	DNP	DNP	477.94	KC

* Alabama State Plane Coordinates calculated from AAAP coordinate for wells not located in field.

ES&E=Environmental Science and Engineering, Inc. SAIC=Science Applications International Corporation DNP=Did not provide. KC=Kimberly-Clark



LEGEND:

- BUILDINGS
- PRIMARY ROADS
- SECONDARY ROADS
- AREA BOUNDARIES
- RAILROAD
- CREEK, TRIBUTARIES AND RIVER
- WETLANDS
- PONDS, IMPOUNDMENTS
- 10' CONTOUR INTERVAL
- GRID BASED ON ALABAMA STATE PLANE EAST

NOTES:

1. BASE MAP OF AREA B RECEIVED FROM AIR SURVEY CORP. MAP COMPILED FROM AERIAL SURVEY FEBRUARY 1995.
2. OUTSIDE AREAS OF BASE MAP RECEIVED FROM AMERICAN DIGITAL CARTOGRAPHY, SCANED FROM USGS CHILDERSBURG 7.5 QUADRANGLE, 1984, 1" = 100,000'.

STATE PLANE GRID

0 800 1600 3200

SCALE: 1" = 1600'

U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

Surface Topography of Area B from Aerial Survey

Figure No.	Project No.	File Name	Date
4-1	01-0828-03-8178-045	99015\DWGS\E42TOPO	03-31-99

4.1.2 Site Geology

Bedrock at ALAAP consists of Cambro-Ordovician Knox Group limestone, dolomitic limestone, and dolomite. The unweathered bedrock lithology consists primarily of massive, gray to tan, microcrystalline, calcareous dolomite and dolomitic limestone. High angle joints and fractures were observed in core samples, with some intensely fractured core intervals that prohibited the accurate calculation of core recovery for those intervals. Calcite-filled veining was pervasive in almost all of the rock core samples. Subsurface conditions (water loss, excessive sand pack requirements, and voids) observed during drilling and descriptions of soil and rock core samples indicate that ALAAP is underlain by variably weathered carbonate bedrock that is susceptible to the development of secondary porosity features. Competent bedrock at the facility is overlain by silty and clayey residuum derived from the subsurface weathering of the carbonate rock. The effects of weathering and surface erosion have resulted in varying degrees and thicknesses of residuum formation ranging from massive and structureless silt and clay soil, to soil with preserved residual rock structure (e.g., joints, fractures, bedding), to transitional horizons of alternating soil and rock intervals (e.g., ledges). Transitional weathering was observed predominantly in the eastern portions of Area B. Alluvial and paludal soils associated with existing surface water drainages, ponds, basins, and marshes on ALAAP consist predominantly of clayey or sandy silt that is localized in extent.

Residuum derived from the weathering of the carbonate bedrock by infiltrating precipitation and groundwater movement comprises the subsurface interval between the ground surface and the top of competent carbonate bedrock. The residuum ranges in thickness from approximately 5 to 121 feet and consists of relatively homogeneous brown, red, or tan clay with trace proportions of sand, silt, and weathered rock fragments. Discrete intervals of sand, silt, silty sand, or silty gravel were encountered in the residuum, but generally were limited in thickness and lateral extent. Relict rock structures resulting from incomplete weathering of the carbonate rock and including joints, fractures, bedding features, voids, and insoluble fragments (chert) were variably observed within the residuum. Resistant chert ledges or boulders may have caused shallow auger refusals in some instances. Secondary relict rock structures preserved as color or textural differences were observed predominantly in the zone of weathered rock overlying the competent bedrock. The geotechnical and geochemical properties of representative soil samples collected from the residuum horizons are provided in **Table 4-2**. Laboratory data for the geotechnical analyses are provided in Appendix F. These data confirm that the site soils are predominantly fine-grained and indicate that the soils are acidic (pH ranging from 3.4 to 7.1 units) with typical cation exchange capacity (CEC) ranging from 5.1 to 20.3 milliequivalents per 100 grams of soil.

Subsurface voids have been encountered at depths between 28 and 169.5 feet below land surface (BLS), and in several instances (locations P-62, P-64, P-67, D-5, D-12, and D-15), voids were encountered at or near the residuum/bedrock interface. Substantial voids requiring excessive sand pack (15,000 pounds at well P-62) or causing the loss of downhole equipment or circulation

Table 4-2. Geotechnical Data Summary
Alabama Army Ammunition Plant, Childersburg, Alabama

Site I.D.	Description	USCS	Depth (feet)	% Sand	% Silt	% Clay	% Gravel	pH[a]	Cation[b] Exchange
GW-02-002	Brown silty sand with gravel	SM	0-2	53.1	21.1	8.2	17.6		
	Brown clayey sand with gravel	SC	14-16	32.9	23.0	19.7	24.4		
	Red brown clayey sand with gravel	SC	29-31	35.4	14.4	16.3	33.9		
	Brown sandy lean clay	CL	34-36	35.2	18.2	33.3	13.3		
	Brown clayey gravel with sand	GC	39-41	26.9	18.4	24.7	30.0		
	Brown clayey sand with gravel	SC	44-46	31.3	18.8	28.6	21.3		
GW-03-002	Dark brown lean clay with sand	CL	0-2	16.0	31.1	26.4	26.5		
	Red brown lean clay with sand	CL	4-6	20.5	33.7	45.8	0.0		
	Tan brown fat clay with sand	CH	29-31	19.2	23.8	53.3	3.7		
GW-03-004	Dark brown clayey gravel	GC	0-2	20.7	31.4	17.9	30.0		
	Tan brown clayey gravel	GC	9-11	16.8	14.4	33.2	35.6		
	Brown lean clay with sand	CL	34-36	17.1	30.0	44.8	8.1		
GW-04-004	Brown sandy lean clay	CL	0-2	15.8	47.5	36.2	0.5		
	Gray and reddish brown fat clay	CH	4-6	10.5	39.9	49.1	0.5		
	Tan brown lean clay with sand	CL	14-16	20.4	23.5	54.3	1.8		
	Light brown sandy lean clay	CL	24-26	23.4	26.2	42.4	8.0		
GW-06-001	Red brown lean clay with sand	CL	0-2	25.4	41.5	33.1	0.0		
	Tan brown sandy elastic silt	MH	14-16	25.2	25.0	42.4	7.4		
	Brown fat clay with sand	CH	19-21	27.8	19.2	52.9	0.1		
GW-06-002	Tan brown and brown sandy lean clay	CL	0-2	41.3	28.5	29.7	0.5		
	Gray lean clay with sand	CL	4-6	20.0	37.5	36.7	5.8		
	Gray brown lean clay with sand	CL	9-11	21.5	36.2	39.1	3.2		
GW-08-001	Red brown sandy lean clay	CL	0-2	16.6	43.2	40.2	0.0		
	Red brown elastic sily	MH	9-11	4.0	17.4	78.6	0.0		
	Reddish brown elastic silt	MH	19-21	9.7	28.2	60.9	1.2		
	Tan brown sandy lean clay	CL	24-26	21.9	25.2	52.9	0.0		
	Brown fat clay with sand	CH	29-31	16.9	24.9	58.2	0.0		
	Brown silt with sand	ML	34-36	25.8	30.0	44.2	0.0		
GW-10-001	D. Gray brown sndy lean clay w/gravel	CL	0-2	32.4	38.4	22.4	6.8		
	Brown sandy silt with gravel	ML	19-21	24.8	24.1	35.7	15.4		
GW-10-006	Brown lean clay with sand	CL	0-2	23.2	32.2	41.1	3.5		
	Dark brown sandy lean clay	CL	9-11	37.6	28.9	29.8	3.7		
	Brown clayey sand	SC	19-21	33.7	17.3	31.9	17.1		
	Tan brown lean clay with sand	CL	24-26	35.6	15.3	49.1	0.0		
GW-17-002	Light brown lean clay with sand	CL	0-2	28.3	45.1	26.6	0.0		
	Light brown fat clay	CH	24-26	15.9	24.3	59.3	0.5		
GW-17-004	Light purplish grey sandy lean clay	CL	0-2	33.9	35.4	30.2	0.5		
	Light brown sandy lean clay	CL	19-21	29.2	18.7	43.1	9.0		
GW-17-006	Dark brown lean clay with sand	CL	0-2	22.6	22.2	55.2	0.0		
	Brown lean clay with sand	CL	14-16	24.8	26.7	43.4	5.1		
GW-18-001	Red brown lean clay with sand	CL	4-6	19.6	26.8	50.6	3.0		
	Tan brown lean clay with sand	CL	14-16	21.8	29.1	47.1	2.0		
	Tan brown lean clay with sand	CL	44-46	20.3	33.9	43.2	2.6		
GW-18-002	Red brown lean clay with sand	CL	4-6	30.5	34.4	34.3	0.8		
	Red brown lean clay with sand	CL	14-16	22.3	34.9	37.9	4.9		
	Red brown lean clay with sand	CL	24-26	36.8	34.1	26.2	2.9		
GW-20-002	Brown clayey sand with gravel	SC	0-2	30.5	32.2	13.8	23.5		
	Tan brown lean clay with sand	CL	4-6	24.1	48.6	25.1	2.2		
	Tan brown sandy lean clay	CL	9-11	25.6	32.6	33.3	8.5		
	Tan brown lean clay with sand	CL	14-16	17.9	27.7	51.3	3.1		
	Dark brown sandy silt	ML	19-21	36.4	37.3	18.9	7.4		
SB-02-001	Gray-brown lean clay with sand	CL	1-3	20.6	43.6	28.7	7.1	6.22	14.32
	**	**	5-7	**	**	**	**	6.26	8.80
	**	**	20-22	**	**	**	**	5.25	12.88
SB-03-005	Red-brown silt with sand	ML	1-3	13.4	29.0	53.6	4.0	5.70	18.64
	**	**	25-27	**	**	**	**	4.75	6.48
SB-04-010	Brown lean clay with sand	CL	1-3	19.2	37.5	35.6	7.7	5.40	14.88
	**	**	20-22	**	**	**	**	4.10	11.52
SB-06-011	Brown fat clay	CH	1-3	11.1	24.9	63.7	0.3	4.70	17.96
	**	**	15-17	**	**	**	**	3.52	18.08
	**	**	25-27	**	**	**	**	3.82	9.64

Table 4-2. Geotechnical Data Summary
Alabama Army Ammunition Plant, Childersburg, Alabama (Continued)

Site I.D.	Description	USCS	Depth (feet)	% Sand	% Silt	% Clay	% Gravel	pH [a]	Cation [b] Exchange
SB-07-020	Brown fat clay with sand	CL	1-3	26.6	43.0	29.6	0.8	4.25	19.64
	**	**	10-12	**	**	**	**	3.81	13.60
	**	**	20-22	**	**	**	**	4.15	10.52
SB-08-023	**	**	20-22	**	**	**	**	4.65	20.32
SB-08-025	Red-brown elastic silt	MH	1-3	6.6	14.1	79.3	0.0	4.08	9.28
	**	**	20-22	**	**	**	**	4.22	17.68
SB-10-030	Tan-brown lean clay with sand	CL	1-3	14.4	48.9	36.1	0.6	4.90	5.12
SB-10-045	**	**	10-12	**	**	**	**	4.85	16.76
	**	**	15-17	**	**	**	**	4.11	7.32
SB-16-063	Light brown fat clay with gravel	CH	1-3	11.7	25.2	48.7	14.4	5.42	13.52
	**	**	4-6	**	**	**	**	4.75	6.96
	**	**	7-9	**	**	**	**	6.00	8.52
SB-18-037	**	**	10-12	**	**	**	**	5.25	10.76
SB-18-037	**	**	15-17	**	**	**	**	4.09	8.24
SB-18-038	Brown lean clay with sand	CL	1-3	16.9	41.8	40.7	0.6	5.00	8.52
SB-19-041	Brown sandy lean clay	CL	1-3	32.9	33.3	30.7	3.1	4.05	8.36
	**	**	15-17	**	**	**	**	5.15	11.12
	**	**	25-27	**	**	**	**	5.88	8.96
SB-20-044	Red-brown lean clay with sand	CL	1-3	21.0	29.8	47.5	1.7	4.25	9.24
	**	**	10-12	**	**	**	**	5.10	12.08
	**	**	20-22	**	**	**	**	5.15	13.08
SB-22-049	Brown sandy lean clay	CL	1-3	41.9	32.6	21.3	4.2	4.98	9.36
	**	**	10-12	**	**	**	**	5.90	12.28
SB-25--050	Tan-brown sandy lean clay	CL	1-3	33.3	38.7	26.0	2.0	4.15	5.52
	**	**	5-7	**	**	**	**	4.88	8.68
SB-BK-054	Tan-brown clayey sand with gravel	SC	1-3	33.2	19.6	25.6	21.6	7.05	9.32
SB-BK-054	**	**	15-17	**	**	**	**	6.40	7.64
SB-BK-054	**	**	25-27	**	**	**	**	5.38	6.08
SS-B6-009	Brown clayey gravel	GC	0-2	29.1	21.8	10.7	38.4		
SS-17-0750	Brown sandy lean clay	CL	0-1.5	33.7	34.3	28.6	3.4	4.77	7.72
SD-05-0000	Gray-brown silt with sand [d]	ML	0	19.4	47.9	26.8	5.9		
SD-09-1040	Brown silty sand [c]	SM	0	57.9	17.1	0.9	24.1		
SD-21-310	Brown lean clay [g]	CL	0	20.1	36.2	30.1	13.6		
SD-26-270	Gray-brown lean clay [f]	CL	0	17.2	41.2	41.6	0.0		
SD-27-100	Brown sandy lean clay [e]	CL	0	30.5	34.4	31.3	3.8		

GW = soil sample from monitoring well, SB = soil sample from soil boring, SD = sediment sample, SS = surface soil sample
Unified Soil Classification System (USCS) :
SM = silty - sands, sand - clay mixtures
SC = clayey sands, sand - clay mixtures
CL = inorganic clays of low to medium plasticity, gravely clays, sandy clays, silty clays, lean clays
GC = clayey gravels, gravel - sand - clay mixtures
CH = inorganic clays of of high plasticity, fat clays
MH = inorganic silts, micaceous or diatomaceous fine sand or silty soils
ML = inorganic silts or very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity

[a] pH electrometric
[b] units equal mg. eq / 100 g.
[c] Aniline Sludge Basin
[d] Red Water Basin
[e] Beaver Pond Drainage
[f] Crossover Ditch
[g] Redwater Ditch
** description and analysis not performed

historically have been encountered beneath Area B (ESE 1986). Subsurface cavities range from open voids to voids containing varying proportions of silt, clay, or rock debris. The subsurface voids that were encountered ranged from less than 1 foot to 40 feet in vertical extent.

The distribution of residuum and bedrock across Area B is shown in cross sections A-A' and B-B' in **Figures 4-2** and **4-3**. The location of the cross sections are shown on Sheet 3-5. The contact between the residuum and the underlying bedrock is gradational, such that weathering along the interface has resulted in either an abrupt soil/rock contact, a weathered rock soil profile with distinct rock characteristics, or a transitional contact consisting of alternating rock ledges and soil horizons. The surface of competent bedrock has been encountered between elevation 340 and 466 feet above msl across the facility. A configuration for the bedrock surface (**Figure 4-4**) based on kriging (neighborhood averaging) of well data encountering bedrock indicates that the bedrock surface slopes broadly from east to west toward the Coosa River. The kriged representation of the bedrock surface is constrained by the available deep well spacing and the irregular weathering of the karst bedrock. Deep soil borings that did not encounter bedrock also were used to refine the mapped surface. The large number of encountered voids in the residuum and bedrock intervals and the large variations in the depth to bedrock over short horizontal distances supports the interpretation of active karst development at the site. Interconnected zones of deeper weathering and other more localized areas of weathering are indicative of fracture concentrations that allowed more active bedrock decomposition by groundwater. Additional details regarding the subsurface geology will be provided in conjunction with the ongoing groundwater investigation.

4.1.3 Site Hydrogeology

Groundwater elevation in wells on ALAAP ranged from 348 to 475 feet above msl between September 1994 and January 1997. The highest groundwater elevation in Area B (elevation 475.01 feet above msl) occurred at well P-28 in an area of elevated topographic relief; however, the groundwater elevation at P-28 was routinely only slightly above the screen bottom elevation and may not provide a true groundwater elevation. Based on well construction concerns, the U.S. Army Corps of Engineers (USACE) (Whitten 1996) has observed that older, shallow wells (P-1 to P-48) installed at ALAAP during earlier investigation efforts may act as sumps and are indicative of intermediate, transient groundwater drainage associated with precipitation events. The next highest groundwater elevation (465.74 feet above msl) was observed at GW-17-005. The groundwater elevation in wells nearer to the Coosa River is approximately 398 to 400 feet above msl in elevation. The depth to groundwater BLS between September 1994 and January 1997 ranged from 0.65 to 117.97 feet with an average depth of 24.9 feet BLS.

Groundwater movement beneath Area B is predominantly to the northwest flowing toward the Coosa River (**Figures 4-5** to **4-8**). Groundwater discharges to local surface water drainages on Area B in the vicinity of the Beaver Ponds and Crossover Ditch, which eventually drain to the

U.S. EPA REGION IV

SDMS

Unscannable Material Target Sheet

DocID: 10723543 Site ID: AL6210020008

Site Name: Alabama Army Ammunition Plant

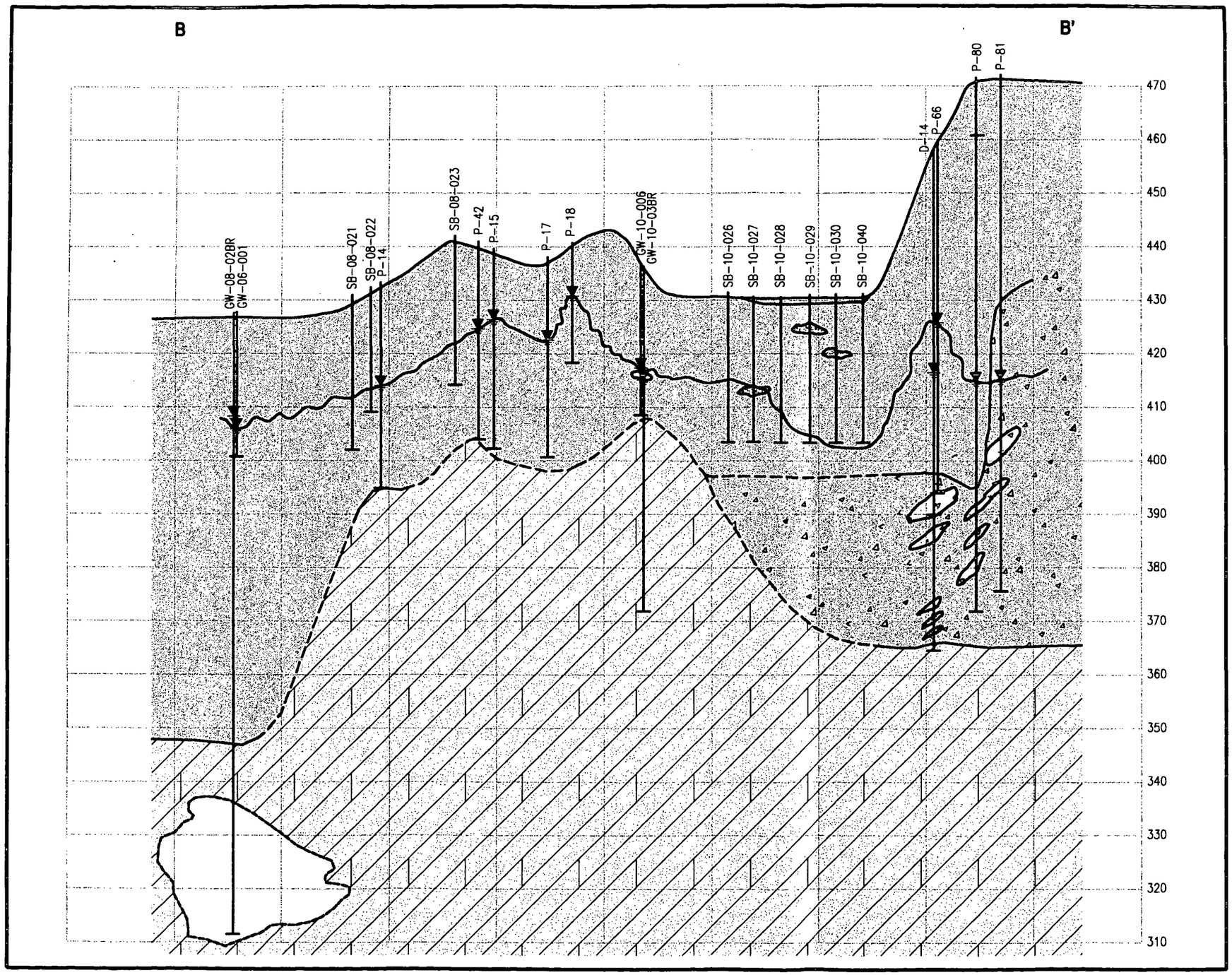
Nature of Material:

Map:	☑	Computer Disks:	☐
Photos:	☐	CD-ROM:	☐
Blueprints:	☐	Oversized Report:	☐
Slides:	☐	Log Book:	☐

Other (describe): Geological Cross Section A-A

Amount of material:

* Please contact the appropriate Records Center to view the material *



LEGEND:

- P-81 — WELL LOCATION
- AVERAGE POTENTIOMETRIC SURFACE ELEVATION
- TOTAL DEPTH OF BORING
- AVERAGE POTENTIOMETRIC SURFACE
- INFERRED AVERAGE POTENTIOMETRIC SURFACE
- RESIDUUM = CLAY, SILT, SILTY AND SANDY CLAYS
- WEATHERED BEDROCK ZONE: CARBONATE AND CHERT LEDGES AND FRAGMENTS IN RESIDUAL CLAY MATRIX
- BEDROCK: VARIBLY FRACTURED LIMESTONE, DOLOMITE, AND DOLOMITIC LIMESTONE OF THE KNOX GROUP
- CLAY, ROCK DEBRIS FILLED VOID
- VOID

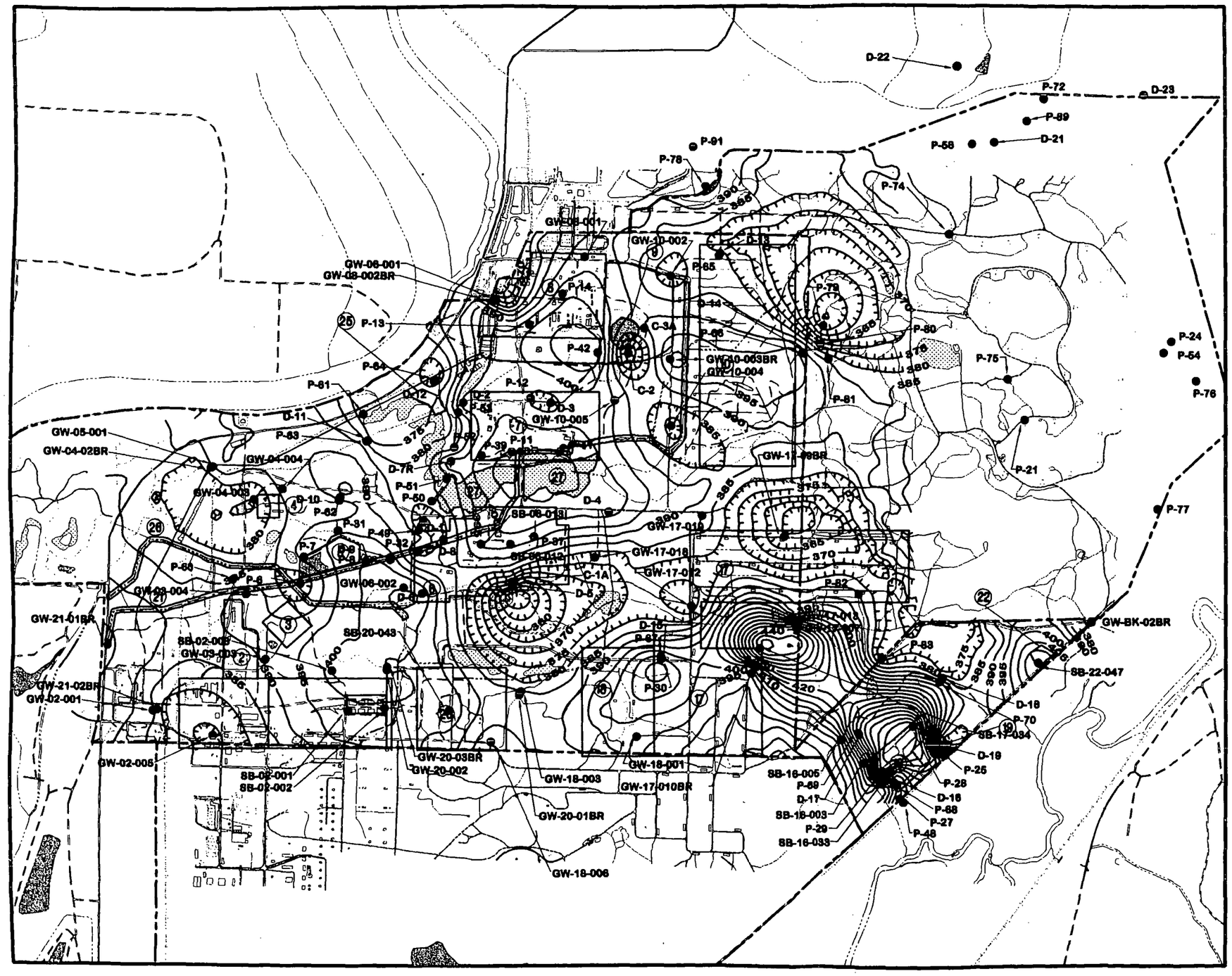
0 5 10 20 40
VERTICAL SCALE: 1" = 20'

0 400 800 1600
HORIZONTAL SCALE: 1" = 800'

U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

Geologic Cross Section
B - B'

Figure No.	Project No.	File Name	Date
4-3	01-0827-03-8178-045	99015\DWGS\E42XSB1	03-31-99



LEGEND:

- BUILDINGS
- PRIMARY ROADS
- SECONDARY ROADS
- AREA BOUNDARIES
- RAIL ROAD
- CREEK, TRIBUTARIES AND RIVER
- WETLANDS
- PONDS, IMPOUNDMENTS
- GW-16-007 MONITORING WELL/SOIL BORING
- 410 BEDROCK SURFACE CONTOUR (5' INTERVAL)

NOTES:

1. BASE MAP OF AREA B RECEIVED FROM AIR SURVEY CORP. MAP COMPILED FROM AERIAL SURVEY FEBRUARY 1995.
2. OUTSIDE AREAS OF BASE MAP RECEIVED FROM AMERICAN DIGITAL CARTOGRAPHY, FROM USGS CHILDERSBURG 7.5 QUADRANGLE, 1984, 1" = 100,000'.

STATE PLANE GRID

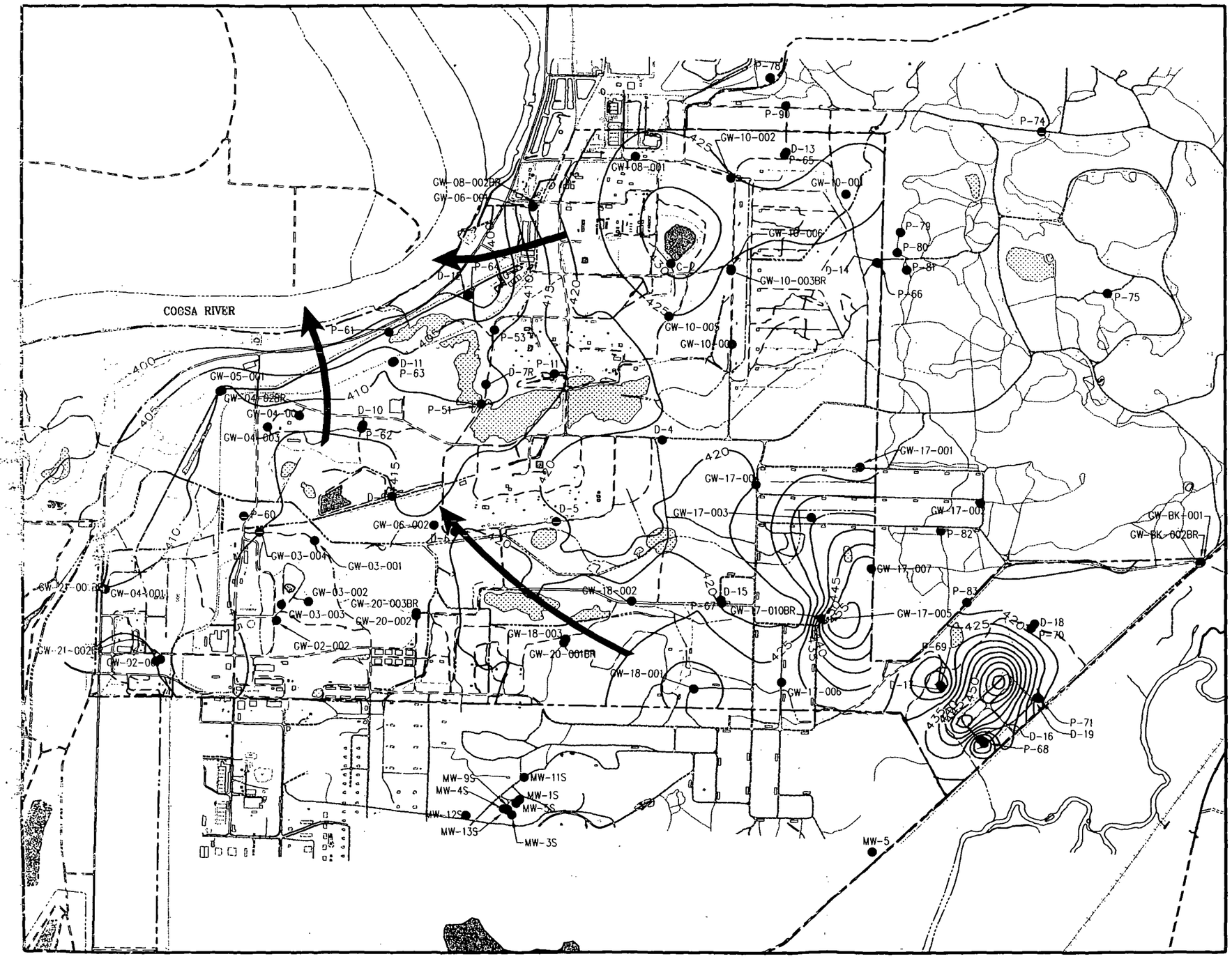
0 900 1800 3600

SCALE: 1" = 1800'

U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

BEDROCK SURFACE MAP

Figure No.	Project No.	File Name	Date
4-4	01-0827-03-8178-045	99015\DWGS\E42BDRK	03-31-99



LEGEND:

- BUILDINGS
- PRIMARY ROADS
- SECONDARY ROADS
- AREA BOUNDARIES
- RAIL ROAD
- CREEK, TRIBUTARIES AND RIVER
- WETLANDS
- PONDS, IMPOUNDMENTS
- ● GW-16-007 MONITORING WELL
- 410 GROUNDWATER ELEVATION CONTOUR (5' INTERVAL)
- GROUNDWATER FLOW DIRECTION

NOTES:

1. BASE MAP OF AREA B RECEIVED FROM AIR SURVEY CORP. MAP COMPILED FROM AERIAL SURVEY FEBRUARY 1995.
2. OUTSIDE AREAS OF BASE MAP RECEIVED FROM AMERICAN DIGITAL CARTOGRAPHY, FROM USGS CHILDERSBURG 7.5 QUADRANGLE, 1984, 1" = 100,000'.

N STATE PLANE GRID

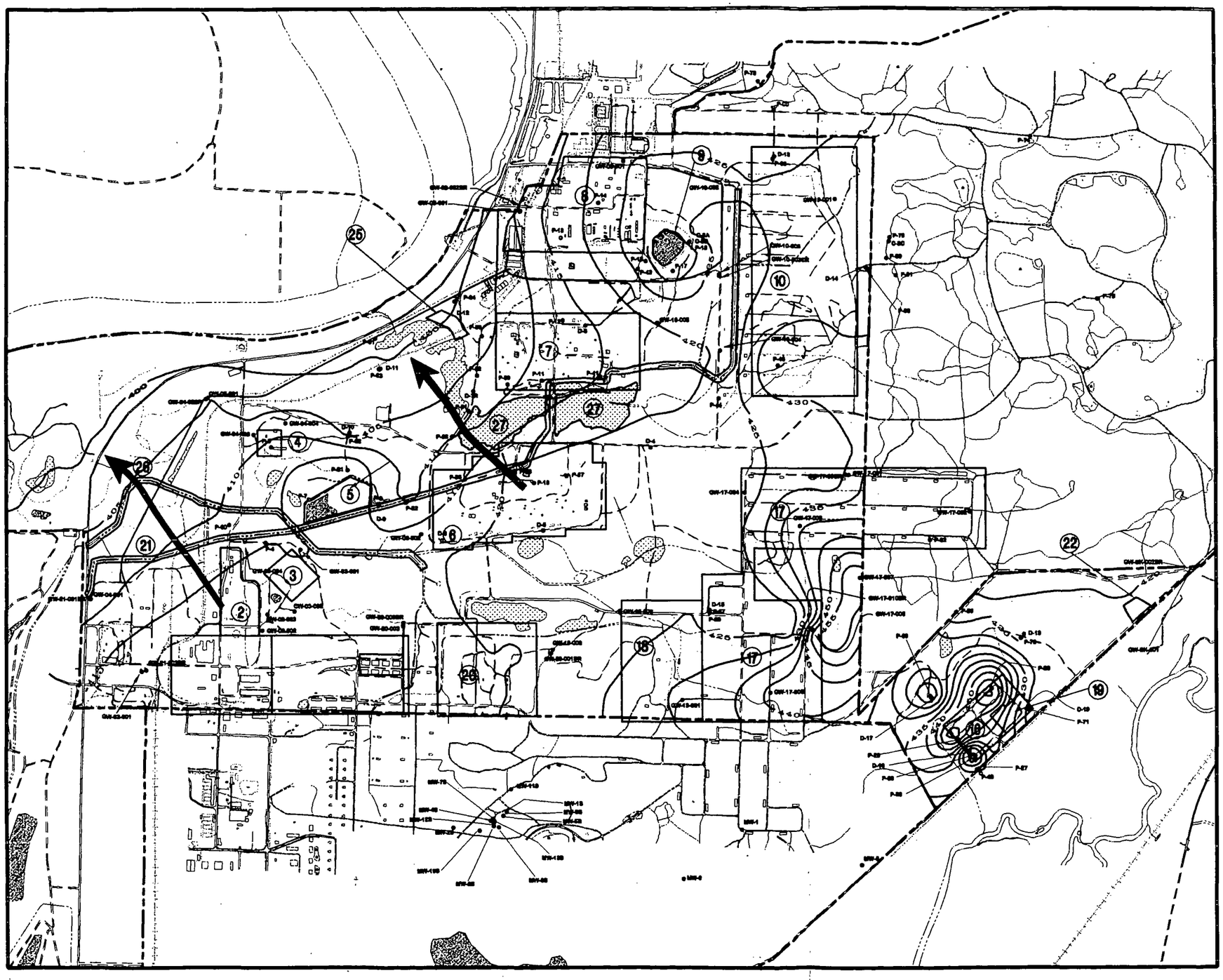
0 800 1600 3200

SCALE: 1" = 1600'

U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

GROUNDWATER ELEVATION CONTOURS
NOVEMBER 1995

Figure No.	Project No.	File Name	Date
4-5	01-0827-03-8178-045	00010\DWGS\E42G1195	08-06-01



LEGEND:

- BUILDINGS
- PRIMARY ROADS
- SECONDARY ROADS
- TRAILS
- FENCE
- AREA BOUNDARIES
- RAIL ROAD
- CREEK, TRIBUTARIES AND RIVER
- WETLANDS
- PONDS, IMPOUNDMENTS
- GW-16-007 MONITORING WELL
- 410 GROUNDWATER ELEVATION CONTOUR (5' INTERVAL)
- GROUNDWATER FLOW DIRECTION

NOTES:

1. BASE MAP OF AREA B RECEIVED FROM AIR SURVEY CORP. MAP COMPILED FROM AERIAL SURVEY FEBRUARY 1995.
2. OUTSIDE AREAS OF BASE MAP RECEIVED FROM AMERICAN DIGITAL CARTOGRAPHY, FROM USGS CHILDERSBURG 7.5 QUADRANGLE, 1984, 1" = 100,000'.

STATE PLANE GRID

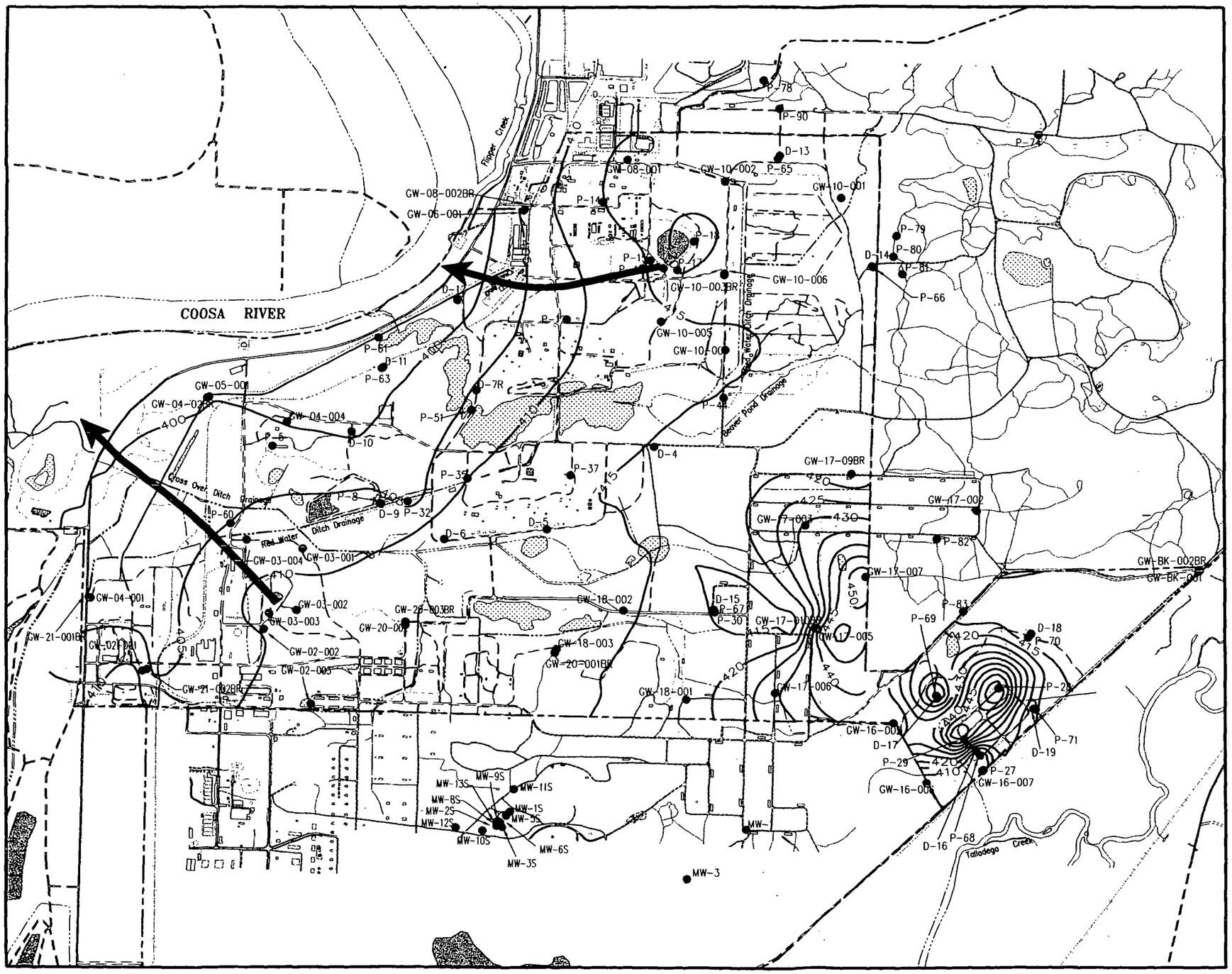
0 800 1600 3200

SCALE: 1" = 1600'

U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

GROUNDWATER ELEVATION MAP
MARCH 1996

Figure No.	Project No.	File Name	Date
4-6	01-0827-03-8178-045	99015\DWGS\E42GW396	03-31-99



LEGEND:

- BUILDINGS
- PRIMARY ROADS
- SECONDARY ROADS
- AREA BOUNDARIES
- RAIL ROAD
- CREEK, TRIBUTARIES AND RIVER
- WETLANDS
- PONDS, IMPOUNDMENTS
- GW-16-007 MONITORING WELL
- 410 GROUNDWATER ELEVATION CONTOUR (5' INTERVAL)
- GROUNDWATER FLOW DIRECTION

NOTES:

1. BASE MAP OF AREA B RECEIVED FROM AIR SURVEY CORP. MAP COMPILED FROM AERIAL SURVEY FEBRUARY 1995.
2. OUTSIDE AREAS OF BASE MAP RECEIVED FROM AMERICAN DIGITAL CARTOGRAPHY, FROM USGS CHILDERSBURG 7.5 QUADRANGLE, 1984, 1" = 100,000'.

STATE PLANE GRID

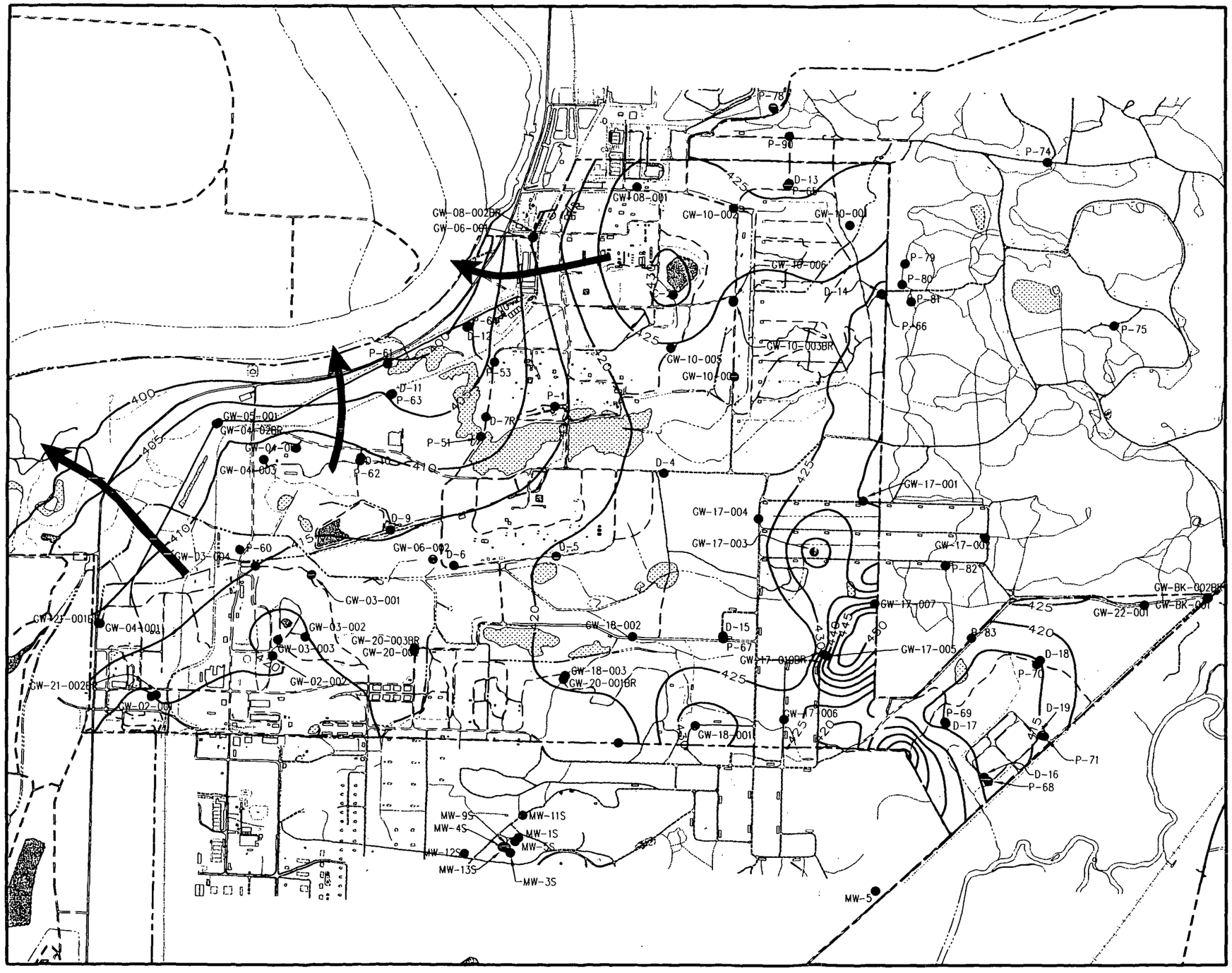
0 800 1600 3200

SCALE: 1" = 1600'

U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

GROUNDWATER ELEVATION MAP
JULY 1996

Figure No.	Project No.	File Name	Date
4-7	01-0827-03-8178-045	99015\DWGS\E42GW796	08-06-01



LEGEND:

- BUILDINGS
- PRIMARY ROADS
- SECONDARY ROADS
- AREA BOUNDARIES
- RAIL ROAD
- CREEK, TRIBUTARIES AND RIVER
- WETLANDS
- PONDS, IMPOUNDMENTS
- GW-16-007 MONITORING WELL
- 410 GROUNDWATER ELEVATION CONTOUR (5' INTERVAL)
- GROUNDWATER FLOW DIRECTION

NOTES:

1. BASE MAP OF AREA B RECEIVED FROM AIR SURVEY CORP. MAP COMPILED FROM AERIAL SURVEY FEBRUARY 1995.
2. OUTSIDE AREAS OF BASE MAP RECEIVED FROM AMERICAN DIGITAL CARTOGRAPHY, FROM USGS CHILDERSBURG 7.5 QUADRANGLE, 1984, 1" = 100,000'.

STATE PLANE GRID

0 800 1600 3200

SCALE: 1" = 1600'

U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

GROUNDWATER ELEVATION MAP
JANUARY 1997

Figure No.	Project No.	File Name	Date
4-8	01-0827-03-8178-045	99015\DWGS\E42GW197	08-06-01

Coosa River. The aquifer underlying the site area consists of generally massive, clayey residuum overlying competent but fractured and dissolutioned carbonate bedrock. Groundwater movement through the soil residuum is predominantly through a macropore network consisting of relict joints, fractures, voids, and relict boulder zones and ledges resulting from differential weathering of the bedrock. Areas of deep weathering indicated by thicker residuum horizons may reflect preferred zones of groundwater movement associated with increased macropore (e.g., joints, fractures, voids) distribution. The configuration of the groundwater surface is a subdued reflection of the surface topography, indicating that the topographic expression provides an indication of local groundwater flow direction. Groundwater movement in the eastern portions of Area B is complicated by the more variable surface topography; the presence of surficial, large-scale solution features (sinkholes); and potential transient shallow aquifer drainage (Whitten 1996) in these areas. Based on the available monitoring data, a groundwater divide may extend across the southern portion of Study Area 17 and extend northeast into Area A and southwest onto the Alliance Forest Products, Inc. (Alliance) (formerly Kimberly-Clark Corporation) property. The precise extent of a groundwater divide through Area A and the Alliance property cannot be established because of the wide spacing of wells in these areas.

The residuum (soil) to bedrock boundary often is saturated in karst environments and provides an avenue for groundwater movement along the interface. Above the groundwater table, infiltrating precipitation encounters the hydraulic conductivity contrast occurring along the interface and flows laterally under the influence of gravity along the top of the bedrock until it reaches the water table. Lesser quantities of groundwater enter directly into the bedrock through joints and fractures.

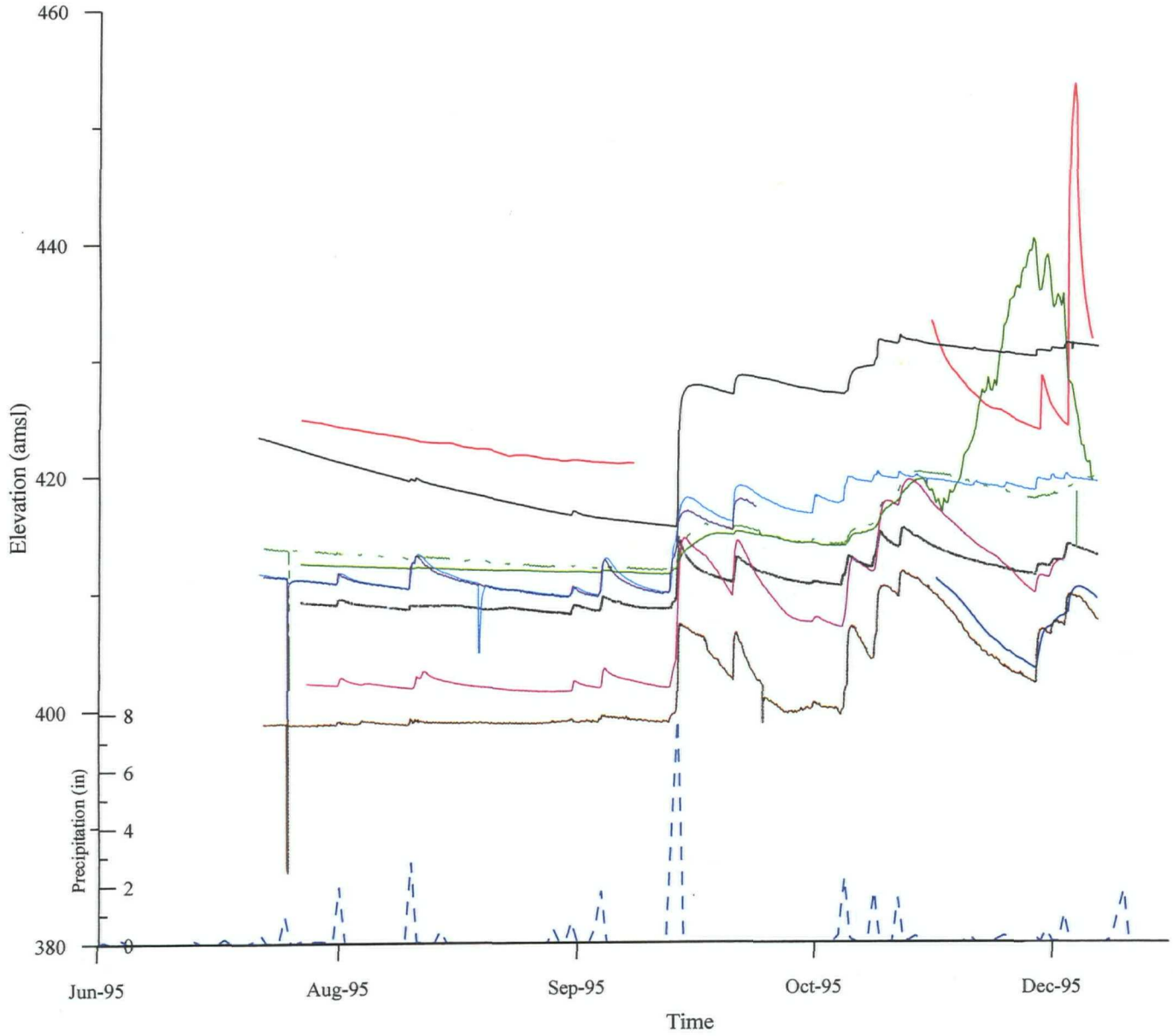
Groundwater underlying Area B varies from acidic (pH = 4.06) to basic (pH = 12.36) with an average pH of 6.8 for all collected samples. The range of pH values determined for the ALAAP wells exceeds the observed range for pH (4.8 to 8.2 pH) in natural groundwater in Talladega County (Moser 1988). Higher pH values (10.58 to 12.36 pH) observed in three newly constructed bedrock monitoring wells (GW-17-010BR, GW-21-002BR, and GW-BK-02BR) exceeded the natural pH range and are possibly impacted by grout infiltration. Groundwater from wells screened in the residuum horizons was acidic (pH = 6.4) with specific conductance averaging 232 microSiemens/cm (µS/cm). Groundwater from wells screened in competent carbonate bedrock was basic (average pH = 7.8) with an average specific conductance of 357 µS/cm. The measured specific conductance of groundwater underlying Area B ranged from 1.1 to 1,517 µS/cm. The lower values may reflect erroneous field measurement. The average pH for wells at ALAAP (6.8 pH units) is lower than the average pH value (7.5 pH units) calculated for Knox Group wells in Talladega County. This difference, however, is not particularly significant because production wells in Talladega County typically are not installed in the poorer-producing residuum horizons. The measured pH in the groundwater underlying Area B is predominantly acidic, varying spatially across the site area with lower pH areas approximately correlating with zones of deeper bedrock weathering and increased specific conductance.

Recharge to the groundwater table is through infiltrating precipitation. The response of the automatic data recorders to precipitation events occurring between July 1995 and May 1997 is shown in **Figure 4-9**. Records from automatic groundwater level recorders installed across Area B indicate that the subsurface response of groundwater elevation to precipitation events is synchronous across the site. This pattern suggests that the macropore system within the residuum is well-developed or that near-surface sinkhole development across the site is more widely distributed. The rapid throughflow of precipitation across Area B suggests that the entire site area may act as a recharge area for the aquifer. The recorder data show that the residuum and bedrock wells respond similarly to precipitation events, indicating that the two horizons are hydraulically interconnected.

Areas of the ALAAP facility contain surface marshes resulting from impeded surface water drainage (Beaver Ponds) or transient, shallow groundwater discharge. Shallow groundwater elevation (409.07 to 416.97 feet above msl at well P-41) in the vicinity of the east Beaver Pond occasionally exceeds mapped surface elevations (412 to 413 feet above msl) in the pond area. Similarly, shallow groundwater elevations in the vicinity of west Beaver Pond (403.61 to 413.93 feet above msl in wells P-11, P-39, P-50, and P-51) and in the swampy area leading from the Beaver Pond to the Coosa River (394.4 to 410.46 feet above msl in wells P-52, P-53, and P-61) occasionally exceed ground surface elevations in the west Beaver Pond (ground elevation approximately 409 feet above msl) and in the swampy discharge area (402.5 feet above msl). These areas also are impacted by impeded surface water flow as a result of beaver dams. The topographically low (elevation 420 to 421 feet above msl) site area between the Southern TNT Manufacturing Area (Study Area 6) and Study Areas 18 and 20 contains localized marshy areas as a result of potentially ponded surface runoff and occasionally elevated groundwater levels (410.01 to 422.16 feet above msl in GW-18-002 and GW-18-003).

Well clusters consisting of paired deep (bedrock) and shallow (residuum) wells are located across Area B (**Table 4-3**). The calculated average vertical hydraulic gradient for all of the well pairs is downward-directed at -0.12 ft/ft. The average vertical hydraulic gradient within bedrock was calculated as -0.04 ft/ft based on data collected from four well pairs screened solely in the carbonate bedrock. Average upward-directed vertical hydraulic gradients ranged from 0.0063 to 0.032 ft/ft at six well pairs (D-5/P-9, P-8/D-9, D-10/P-62, D-12/P-64, D-15/P-67, and GW-06-001/ GW-08-002BR). The average horizontal hydraulic gradient for Area B was calculated through the central portion of the area using groundwater elevation maps (November 1995, March 1996, July 1996, and January 1997) as 0.005 ft/ft. Steeper horizontal hydraulic gradients are evident in the eastern portion of Area B associated with more complex surface topography and in the western portion of ALAAP in the vicinity of the Acid/Organic Manufacturing Area (Study Area 8).

Aquifer slug testing was conducted at 42 monitoring wells in Area B during Phase 1 of the Supplemental RI to obtain estimates of the aquifer hydraulic conductivity at the new well locations and supplemental information at locations that previously were not tested. Additional information



LEGEND:

- P-26
- GW-10-001
- GW-17-009BR
- GW-17-004
- GW-20-002
- GW-20-003BR
- P-11
- GW-06-001
- GW-04-003
- GW-04-02BR
- Precipitation

NOTES:

Precipitation data from NOAA, Childersburg, Alabama Field Station.

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CHILDERSBURG, ALABAMA

GROUNDWATER ELEVATION AUTOMATIC DATA RECORDERS July, 95 to December, 95

Figure No.	Project No.	File Name	Date
4-9	01-0827-03-8178-045	99015\DWGS\E42F4-5	08-06-01

Table 4-3. Groundwater Elevation - Well Pairs
Alabama Army Ammunition Plant, Childersburg, Alabama

Well/Boring	East	North	Sept-94	Jan-95	May-95	July-95	Sept-95	Average	Mid Screen	Calculated Vertical Hydraulic Gradient Sept-94	Jan-95	May-95	July-95	Sept-95	Avg. VGrad
C-3A	504720.38	1037344.81	418.61	426.28	430.93	418.43		423.5625	45.9						
C-3B	504713.68	1037337.28	421.62	431.53	434.92	431.24		429.8275	24.5						
C-3C	504719.94	1037336.25	421.86	431.22	435.04	431.6		429.93	33.7						
P-18	504709.53	1037330.81	421.56	431.49	434.03	421.14	441.48	429.94	15						
D-9	500053.25	1033387.72	407.18	412.5	413.23	406.65	405.07	408.926	45.5	0.009310345	0.0117241	0.0096552	0.0072414	0.0062069	0.0088276
P-8	500043.03	1033400.13	406.91	412.16	412.95	406.44	404.89	408.67	16.5						
D-10	499617.02	1034476.17	399.19	402.27	404.49	398.89	398.59	400.686	73	0	-0.007075	-0.004009	0.0004717	0.0011792	-0.001887
P-62	499601.52	1034425.91	399.19	402.57	404.66	398.87	398.54	400.766	30.6						
D-11	500085.19	1035438.24	397.95	398.99		397.62	397.75	398.0775	87.8	-0.016695652	-0.043304		-0.012	-0.00487	-0.019217
P-63	500064.94	1035425.63	398.91	401.48		398.31	398.03	399.1825	30.3						
D-12	501195.64	1036445.39	397.96	399.18	399.33	397.5	397.88	398.37	92.5	-0.003015873	-0.039841	-0.003968	-0.003175	-0.001587	-0.010317
P-64	501217.52	1036455.75	398.15	401.69	399.58	397.7	397.98	399.02	29.5						
D-13	505991.84	1038609.21	413.88	417.85	420.8	414.47	411.67	415.734	94	-0.099587629	-0.102474	-0.047423	-0.02268	-0.012577	-0.056948
P-65	505969.25	1038570.79	418.71	422.82	423.1	415.57	412.28	418.496	45.5						
D-14	507376.49	1036942.72	414.22	418.12	420.26	414.82	411.96	415.876	88	-0.17852349	-0.368121	-0.428859	-0.138255	-0.095638	-0.241879
P-66	507398.89	1036929.50	419.54	429.09	433.04	418.94	414.81	423.084	58.2						
D-15	505002.83	1031811.48		417.44	419.77	413.2	410.69	415.275	75.5		-0.222333		-0.295833	-0.333833	-0.258792
P-30	505005.26	1031776.42	430.76	430.78		430.95	430.72	430.8025	15.5						
P-67	505011.84	1031769.32	412.76	417.66	419.89	413.33	410.69	414.866	40.1		-0.006215	-0.00339	-0.003672	0	0.0115537
D-16	508912.62	1029697.78	409.02	411.89	413.63	408.26	406.62	409.884	183	-0.103913043	-0.088478	-0.148043	-0.134638	-0.104203	-0.115855
P-26	508987.74	1029632.09	423.36	424.1	434.06	426.84	421	425.872	45						
P-68	508971.23	1029636.49	408.65	412.96	414.39	408.87	407.24	410.422	89.5	-0.330561798	-0.250337	-0.442022	-0.40382	-0.309213	-0.347191
P-27	509022.40	1029413.87	434.13	440.41	437.47	434.3	434.28	436.118	16.5	0.581395349	0.8186047	0.8325581		0.0023256	0.5234884
P-48	509082.33	1029354.36	426.63	429.85	426.73		434.25	429.365	3.6						
GW-BK-001	512226.16	1032374.33				411.59	409.17	410.38	35.3						
GW-BK-02BR	512241.66	1032388.35				410.95	408.77	409.86	70				-0.018444	-0.011527	-0.014986
GW-02-001	496488.03	1030888.44			418.69	410.44	408.99	412.70667	30.62						
GW-21-002BR	496555.59	1030910.34				347.68	357.52	352.6	76						
GW-04-02BR	497461.20	1034983.83				398.95	398.54	398.745	53.75				-0.026156	0.015311	-0.005423
GW-05-001	497490.00	1034998.75				399.77	398.06	398.915	22.4						
GW-04-001	495715.69	1031975.61				402.24	401.36	401.8	20.1						
GW-21-001BR	495688.93	1031983.88				372.69	400.45	386.57	52.6				-0.909231	-0.028	-0.468615
GW-06-001	502181.46	1037792.12			398.81	402.9	402.38	401.36333	23.8						
GW-08-002BR	502193.23	1037804.37				403.17	402.6	402.885	90.7				0.0040359	0.0032885	0.0227454
GW-10-003BR	505160.72	1036821.48				410.86	411.83	411.345	52.36				-0.138993	0.0003109	-0.145782
GW-10-006	505163.36	1036846.49			420.95	415.33	411.82	416.03333	20.2						
GW-17-001	507112.61	1033835.42			431.27	426.59	426.59	428.15	31.85						
GW-17-009BR	507067.89	1033835.84				414.53	411.8	413.165	109.6				-0.155113	-0.190225	-0.192733
GW-17-005	505558.22	1031509.09			461.11	449.76	449.48	453.45	40.87				-0.432	-0.454986	-0.486648
GW-17-010BR	506513.92	1031527.53				411.42	409.1	410.26	129.62						
GW-18-003	502659.05	1031215.72			420.06	413.12	410.01	414.39667	40.75						
GW-20-001BR	502632.86	1031160.64				412.54	409.89	411.215	61.2				-0.028362	-0.005868	-0.155583
GW-20-002	500409.84	1031571.70			418.44	412.54	410.99	413.99	14.43						
GW-20-003BR	500414.99	1031619.83				412.28	410.59	411.435	46				-0.008236	-0.01267	-0.080931
D-5	502522.30	1033005.93			419.71	413.62	410.96	414.76333	95						-0.002489
P-9	502521.05	1033073.61		414.95				414.95	20						

obtained from previous testing conducted by ESE between 1983 and 1993 in Areas A and B also was used to assess the distribution of calculated hydraulic conductivity values on ALAAP. Hydraulic conductivity testing has been conducted at 99 locations during all investigative phases on the ALAAP facility, including 52 wells screened in residuum, 40 wells screened in bedrock, and 7 wells screened in both residuum and bedrock. The hydraulic conductivity of wells screened in residuum (and residuum/bedrock) ranged from 1.47×10^{-6} to 7.6×10^{-1} cm/sec with a geometric average of 3.62×10^{-4} cm/sec. Bedrock hydraulic conductivity ranged from 6.24×10^{-8} to 1.56×10^{-1} cm/sec with a geometric average of 7.50×10^{-4} cm/sec.

The distribution of hydraulic conductivity values was evaluated statistically using the probability plot correlation coefficient as a measure of the correspondence of the data set to a normal distribution. The measured hydraulic conductivity values are lognormally distributed based on the higher correspondence of the logarithmically transformed data to a normal distribution. The measured hydraulic conductivity values for bedrock and residuum also were determined to be from the same statistical population based on a t-test statistical comparison of residuum values to bedrock values (Appendix G). The overall hydraulic conductivity of the materials underlying ALAAP range from 6.24×10^{-8} to 7.6×10^{-1} cm/sec with a geometric average of 5.66×10^{-4} cm/sec. The distribution of hydraulic conductivity across Area B is shown in **Figure 4-10**. The gridded hydraulic conductivity field indicates a pronounced northwest-southeast directed anisotropy. Calculated hydraulic conductivity values for the newly installed (Phase 1) wells ranged from 4.26×10^{-7} to 4.99×10^{-2} cm/sec, which falls within the overall range (6.24×10^{-8} to 7.6×10^{-1} cm/sec) of previously determined values. **Table 4-4** summarizes the calculated values for each well, and data plots for each test are provided in Appendix G.

4.2 DATA QUALITY ASSESSMENT

All environmental (i.e., soil, sediment, surface water, groundwater, and biota) samples and field quality control (QC) blanks (i.e., trip blanks and equipment rinsates) collected during the Supplemental RI at ALAAP were analyzed using U.S. Army Environmental Center (USAEC) and U.S. Environmental Protection Agency (EPA) methods from the following references:

- *USAEC Class 1, 1A, and 1B Performance Demonstrated Methods* (volatile organic compounds [VOCs], semivolatile organic compounds [SVOCs], pentachlorophenol [PCP], pesticides/polychlorinated biphenyls [PCBs], explosives and explosives breakdown products [waters only], metals, nitrate [waters only], and phosphate [waters only])

- *Test Methods For Evaluating Solid Waste, Physical/Chemical Methods*, SW846 (total petroleum hydrocarbons [TPH], total organic carbon [TOC], hexavalent chromium, polycyclic aromatic hydrocarbons [PAHs], explosives and explosives breakdown products [soils only], and all biota analysis [i.e., explosives and explosives breakdown products, SVOCs, pesticides/PCBs, hexavalent chromium, and metals])

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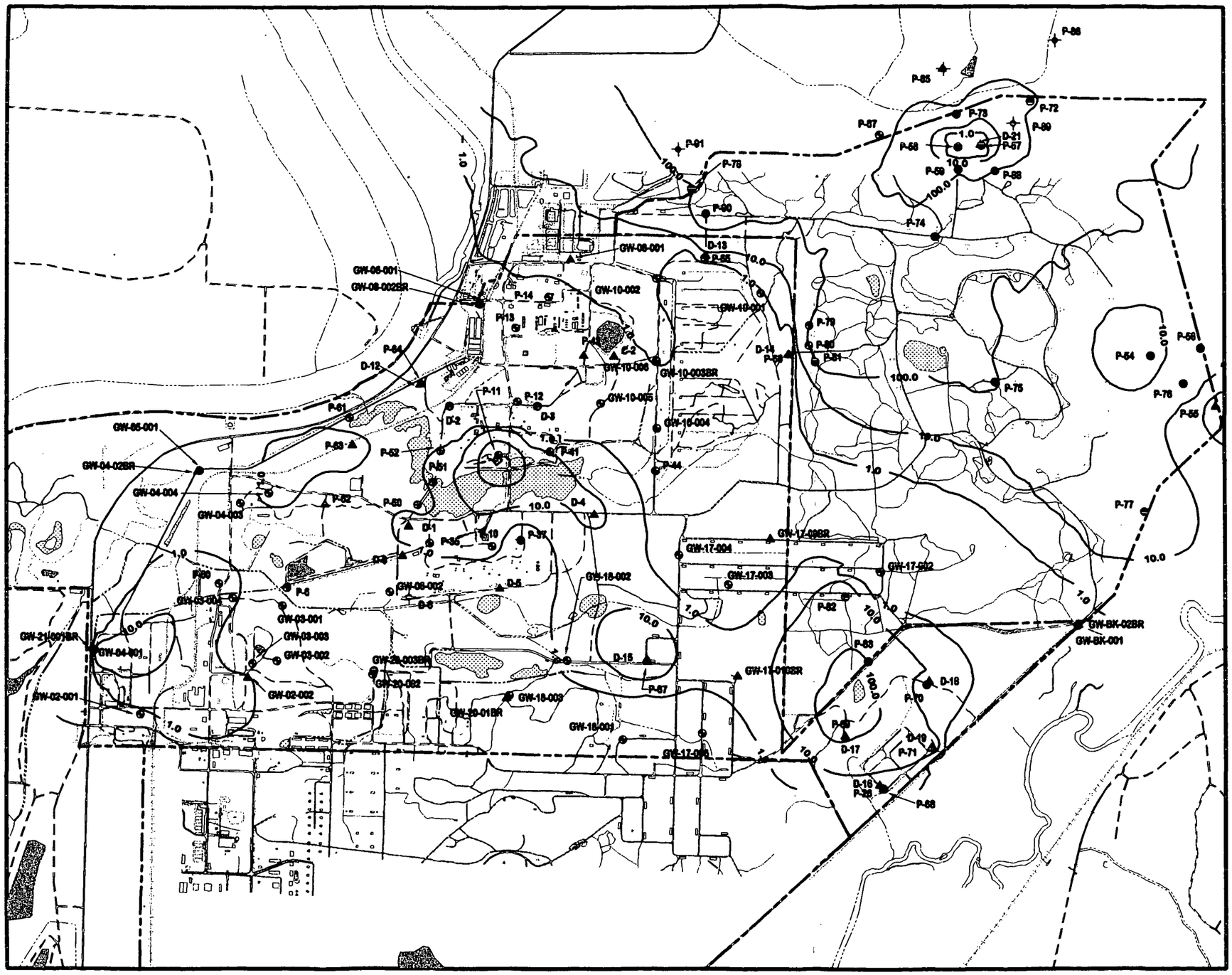

LEGEND:

- BUILDINGS
- PRIMARY ROADS
- SECONDARY ROADS
- AREA BOUNDARIES
- RAIL ROAD
- CREEK, TRIBUTARIES AND RIVER
- WETLANDS
- PONDS, IMPOUNDMENTS
- P-77 — BEDROCK WELL
- GW-10-002 — RESIDUUM WELL
- P-91 — RESIDUUM/BEDROCK WELL
- GW-BK-02BR — WELLS ENCOUNTERING VOIDS OR REQUIRING EXCESSIVE SANDPACK
- 100 — HYDRAULIC CONDUCTIVITY CONTOUR (FT./DAY)

NOTES:

1. BASE MAP OF AREA B RECEIVED FROM AIR SURVEY CORP. MAP COMPILED FROM AERIAL SURVEY FEBRUARY 1995.
2. OUTSIDE AREAS OF BASE MAP RECEIVED FROM AMERICAN DIGITAL CARTOGRAPHY, FROM USGS CHILDERSBURG 7.5 QUADRANGLE, 1984, 1" = 100,000'.

STATE PLANE GRID

0 900 1800 3600

SCALE: 1" = 1800'

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HYDRAULIC CONDUCTIVITY MAP

Figure No.	Project No.	File Name	Date
4-10	01-0827-03-8178-045	99015\DWGS\E42HYCN	03-31-99

Table 4-4. Results of Slug Test Analysis
Alabama Army Ammunition Plant, Childersburg, Alabama

Well/Boring	Type	East	North	Hydraulic conductivity cm/sec	Hydraulic conductivity ft/day	Analysis Method
GW-BK-001	Soil	512226.16	1032374.33	4.600E-05	0.1304	Bouwer-Rice
GW-BK-02BR	Bedrock	512241.66	1032388.35	7.711E-04	2.1859	Cooper et al
GW-02-001	Soil	496488.03	1030888.44	2.380E-04	0.6746	Cooper et al
GW-02-002	Soil	498301.05	1031504.63	1.160E-03	3.2882	Cooper et al
GW-03-001	Soil	498876.86	1032717.36	2.460E-04	0.6973	Cooper et al
GW-03-002	Soil	498786.95	1031790.04	1.510E-06	0.0043	Bouwer-Rice
GW-03-003	Soil	498379.12	1031746.72	2.790E-06	0.0079	Bouwer-Rice
GW-03-004	Soil	498042.24	1032846.15	4.750E-04	1.3465	Bouwer-Rice
GW-04-001	Soil	495715.69	1031975.61	4.990E-02	141.4488	Cooper et al
GW-04-02BR	Bedrock	497461.20	1034983.83	1.257E-05	0.0356	Bouwer-Rice
GW-04-003	Soil	498173.68	1034445.75	1.470E-06	0.0042	Bouwer-Rice
GW-04-004	Soil	498653.05	1034617.68	3.510E-03	9.9496	Cooper et al
GW-05-001	Soil	497490.00	1034998.75	4.410E-05	0.1250	Cooper et al
GW-06-001	Soil	502181.46	1037792.12	3.390E-04	0.9609	Cooper et al
GW-06-002	Soil	500682.06	1032951.72	1.760E-04	0.4989	Cooper et al
GW-08-001	Soil	503726.80	1038550.28	1.030E-03	2.9197	Cooper et al
GW-08-002BR	Bedrock	502193.23	1037804.37	1.890E-04	0.5357	Cooper et al
GW-10-001	Soil	506907.74	1037972.63	2.270E-04	0.6435	Cooper et al
GW-10-002	Soil	505167.90	1038226.84	8.320E-04	2.3584	Cooper et al
GW-10-003BR	Bedrock	505160.72	1036821.48	8.524E-07	0.0024	Bouwer-Rice
GW-10-004	Soil	505175.51	1035702.11	2.170E-05	0.0615	Cooper et al
GW-10-005	Soil	504227.39	1036127.52	2.090E-04	0.5924	Bouwer-Rice
GW-10-006	Soil	505163.36	1036846.49	3.140E-03	8.9008	Cooper et al
GW-17-002	Soil	508927.24	1033284.70	1.990E-06	0.0056	Bouwer-Rice
GW-17-003	Soil	506371.43	1032658.89	1.130E-05	0.0320	Bouwer-Rice
GW-17-004	Soil	505536.14	1033570.19	5.530E-04	1.5676	Bouwer-Rice
GW-17-006	Soil	505913.67	1030566.19	3.320E-06	0.0094	Bouwer-Rice
GW-18-001	Soil	504589.65	1030462.76	1.590E-06	0.0045	Bouwer-Rice
GW-18-002	Soil	503659.04	1031794.63	9.940E-04	2.8176	Cooper et al
GW-18-003	Soil	502659.05	1031215.72	1.890E-06	0.0054	Bouwer-Rice
GW-20-001BR	Bedrock	502632.86	1031160.64	2.400E-04	0.6803	Cooper et al
GW-20-002	Soil	500409.84	1031571.70	3.474E-05	0.0985	Bouwer-Rice
GW-20-003BR	Bedrock	500414.99	1031619.83	1.314E-04	0.3724	Cooper et al
GW-20-001BR	Bedrock	502632.86	1031160.64	1.263E-04	0.3581	Cooper et al
GW-21-001BR	Bedrock	495688.93	1031983.88	2.835E-07	0.0008	Bouwer-Rice
P-12	Soil	502822.38	1036160.17	3.466E-04	0.9824	Cooper et al
P-13	Soil	502798.05	1037400.61	5.542E-04	1.5710	Bouwer-Rice
P-14	Soil	503354.27	1037921.55	2.630E-04	0.7455	Cooper et al
P-50	Soil	501153.49	1034417.97	3.327E-05	0.0943	Bouwer-Rice
P-51	Soil	501405.85	1034797.54	9.912E-04	2.8098	Cooper et al
P-52	Soil	501534.88	1035329.68	6.556E-04	1.8583	Cooper et al

*Testing conducted at wells GW-17-009 and GW-07-010 was inconclusive.
Well GW-21-002BR was not tested because of low water productivity.

- *Methods for Chemical Analysis of Water and Wastes,* EPA 600/4-79-020, 1983 with additions (nitrate [soils only], phosphate [soils only], and TOC [waters only]).

During the review and evaluation process, 15 percent of Phase 1 and 30 percent of Phase 2, 3, and 4A analytical data generated by USAEC methods and 100 percent of the data generated by non-USAEC methods were subjected to a systematic and rigorous technical process by examining all analytical QC results and laboratory documentation, following the appropriate guidelines for laboratory data validation. This section provides an assessment of the quality assurance (QA)/QC results from the Supplemental RI to confirm that the data used in this report meet the data quality objectives (DQOs) established for this investigation. Both quantitative measures and qualitative assessments will be presented to characterize these data as having sufficient quality to satisfy these objectives. The primary intent of this assessment is to illustrate that data originating from the Supplemental RI can withstand scientific scrutiny, are technically defensible, and are of a known and acceptable precision and accuracy. All data were validated using the guidelines and specifications described in the following documents:

- *User's Guide, Installation Restoration Data Management Information System (IRDMIS), Volume II Data Dictionary* (USAEC 1995a).
- *Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses*, EPA Contract Laboratory Program (CLP), February 1988 (VOCs, SVOCs, and pesticides/PCBs)
- *Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses*, EPA CLP, February 1988 (metals)
- *U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) Quality Assurance Program, PAM 11-41* (January 1990).

All data were flagged and qualified using IRDMIS. Each data point was assessed to determine whether the value was considered usable (i.e., no IRDMIS flagging code) or usable but outside QC criteria. All IRDMIS flagging codes applied to all data as necessary by ESE; PACE Environmental Laboratories; EA Engineering, Science, and Technology, Inc.; and SAIC are contained in the comprehensive data summary tables in Appendix K. All IRDMIS qualifiers as applied by the USAEC chemist are defined at the bottom of each table presenting analytical data.

After the validation process is complete, the following data are used in the discussion of the nature and extent of contamination:

- Data with detected analytes that have no IRDMIS data qualifiers or flagging codes
- Data with detected analytes that have IRDMIS data qualifiers or flagging codes other than A, B, G, +, I, U, and R

- "Not detected" results are treated as one-half the limit of detection
- Sample results with IRDMIS flags A, B, G, +, I, and U are treated as not detected and are included in the risk assessment as one-half the limit of detection; these flags are explained in greater detail in the Data Quality Assessment (Appendix I).

The following are excluded from the analysis of the nature and extent of contamination:

- Data in which analytes were rejected during data validation.
- Field duplicates. Field duplicates are QA/QC samples that were collected to assess variability in the sampling process; therefore, they are discussed in Section 4.2.1 and Appendix I, but the analytical results are not included in the discussion of nature and extent of contamination or in the calculation of exposure point concentrations.

Appendix I presents the number of soil, sediment, surface water, groundwater, and biota samples collected during the Supplemental RI, in addition to the number of field QC samples collected and selected laboratory QC (i.e., matrix spikes/matrix spike duplicates [MS/MSDs] on non-USAEC performance demonstrated methods) samples analyzed. The data validation worksheets are referenced within the subsection describing the applicable analysis. The QC checks and results are summarized below.

4.2.1 Field Data

The following sections describe the field data quality assessment and surveillance of field site activities.

4.2.1.1 Field Data Quality Assessment

The following sections summarize the field DQOs for the precision, accuracy, representativeness, comparability, and completeness (PARCC) parameters obtained during the Supplemental RI at ALAAP. Appendix I provides an in-depth discussion of the field PARCC parameters. Appendix C provides a data quality assessment for the analytical work completed in the field laboratory.

Precision—Sampling precision and spatial variability of contamination can be assessed through the analysis of field duplicates. Field duplicate samples assess the precision of the sampling techniques and spatial variability of the contamination. Field duplicate samples were included as part of the Supplemental RI and were collected at a rate of 1 duplicate per 10 field samples using the same techniques as those used to collect the environmental samples. Specific control limits for field precision were not established in part because the natural heterogeneity of the environmental media was much greater than the variability imparted by field activities.

Field relative percent difference (RPD) values were calculated only for compounds and elements detected in concentrations greater than the certified reporting limits (CRLs) in both duplicate pair samples or in one sample. A statistical summary may show how far each individual RPD value departed from the mean. The sample RPD assesses the impact of the field sampling analysis on a pair of duplicate pairs. Table I-2 of Appendix I provides a summary, by medium and by analyte, of the RPD and absolute difference for field replicates. As one might expect, soil heterogeneity imparts a large degree of uncertainty as to what might be considered representative values. Average RPDs were calculated only for that analyte or compound detected in at least two field duplicate pairs. Average RPDs in soil range from roughly 17.6 to 105.7 percent for metals, 138.1 to 153.4 percent for VOCs, 21.1 to 126.8 percent for SVOCs, 100.2 to 200 percent for explosives, and 42.7 percent for TOC. Average RPDs in water range from 3.8 to 56.4 percent for metals, 45.8 to 200 percent for VOCs, 52.9 to 146.2 percent for SVOCs, 10 to 200 percent for explosives, and 57.3 to 131.7 percent for PAHs. The soil field duplicates were more variable than the water field duplicates, as deduced from average values. Overall, project precision for environmental analyses has been determined to be adequate for the uses of the analytical data, which were to identify the contaminants and provide an assessment of the distribution of each analyte (i.e., the spread of the reported values about their mean) in both soil and water matrices. A comprehensive discussion of all field duplicate sample results is presented in Sections I.2.4 and I.6 of Appendix I.

Accuracy—Sampling accuracy was maximized by the adherence to the strict QA program presented in the ALAAP Supplemental RI Quality Assurance Project Plan (QAPP) (SAIC 1995b). Field QC blanks (i.e., source water, trip blanks, and equipment rinsates) were prepared to ensure that all samples represent the particular study area from which they were collected, assess any cross-contamination that may have occurred, and qualify the associated analytical data accordingly.

During the ALAAP Supplemental RI sampling program, approximately 19 percent of the samples collected during the program were field QC blanks (i.e., trip blanks and equipment rinsates) obtained to determine the degree of cross-contamination or ensure successful decontamination procedures. The majority of the trip blank results were generally below the CRLs. An IRDMIS flagging code "A" was applied to 27 acetone, 33 methylene chloride, 19 toluene, 1 methyl ethyl ketone (MEK), and 2 carbon disulfide and chloroform concentrations to indicate that the flagged concentrations were detected in the associated trip blanks and did not exceed 10 times the concentrations detected in the associated trip blank. The "-" flag in combination with the "A" flag indicates that the sample concentration is considered to be site related. Therefore, all low-level acetone, methylene chloride, toluene, MEK, carbon disulfide, and chloroform detects in these field samples are highly suspect and should be considered potential false positives.

The flagging code "G" or "G+" was applied to 1 MEK, 23 methylene chloride, 50 toluene, 38 acetone, 3 carbon disulfide, 6 chloroform, 41 bis(2-ethylhexyl)phthalate (B2EHP),

14 indeno(1,2,3-cd)pyrene, 67 2,4-dinitrotoluene (2,4-DNT), 20 potassium, 2 selenium, 3 copper, and 3 zinc concentrations to indicate that these concentrations were detected in the associated rinsate blanks. A "G" flag (1995 data) or a "G+" flag (1996–1997 data) indicates that the concentrations detected in the environmental samples did not exceed 10 or 5 times the concentrations detected in the associated equipment rinsate and are considered false positives due to equipment rinsate contamination. The "-" flag in combination with the "G" flag indicates that the sample concentration is considered to be site related. Despite the flagging codes, these field QC results are not considered to have affected the sample data quality adversely. Based on an evaluation of the compounds and elements detected in the field QC blanks, the overall field accuracy is acceptable, except where noted. As a result, the field DQO for accuracy is considered to have been met. Sections I.2 and I.6 of Appendix I presents a comprehensive discussion of the field QC results. Table I-4 of Appendix I summarizes the data flags and qualifiers applied to the data.

From May 17 to June 19, 1995, samples were prepared for shipment in a trailer where the field screening activities were occurring. These activities included the extraction of screening samples with acetone. Therefore, samples being packaged for shipment to the laboratory may have been exposed to acetone during this time period. Initial results containing high concentrations of acetone were recognized and the SAIC QA Manager was notified. The probable source of acetone was identified (field screening analysis of samples) and immediate remedial actions were taken. The field screening laboratory was physically separated from sample handling and packaging activities, and the field trailer was decontaminated. However, any acetone concentrations detected in these field samples may be biased high due to this field laboratory contamination. These samples have not been assigned an IRDMIS flag because no such flag exists for this type of exposure.

Representativeness—Representativeness is defined as the degree to which the data accurately and precisely represent a characteristic of a population, parameter variations at a sampling location, a process condition, or an environmental condition. The soil sampling approach was a variation of probability (statistical) sampling and the search sampling typically used in locating suspected "hot spots." Historical data from the ESE RI were reviewed and probability sampling was designed to ensure that the quality and quantity of the environmental sampling would properly characterize the study areas. Soil data obtained from these sampling approaches have the following limitations: concentrations may not represent the average soil contamination and the distribution of contaminant concentrations may not accurately represent the distribution over the entire base. The sampling approach used in collecting groundwater samples was a variation of probability sampling and purposive/judgmental sampling. Purposive/judgmental sampling is a potentially biased approach in which each sampling is based on a predetermined conceptual model or understanding of contamination. Holding times and preservation criteria are based on the most restrictive holding times recommended by USAEC and/or EPA for water and soil matrices. Sample representativeness was ensured during the Supplemental RI by collecting sufficient samples of a population medium, properly distributed

with respect to location and time. Representativeness was assessed by reviewing the drilling techniques and equipment, sample collection methods, equipment, and sample containers used during the Supplemental RI, in addition to evaluating the RPD values calculated from the duplicate samples. Intervals for soil sampling were chosen to obtain the strata with the highest concentrations of contaminants in order to achieve the most conservative representation and to optimize the number of samples required.

Based on the evaluation of the factors described in the previous section and summarized in Appendix I, the samples collected during the Supplemental RI are considered to be representative of the environmental condition at ALAAP.

Comparability—Comparability is a qualitative parameter expressing the confidence with which one data set can be compared to another, and is limited to the other PARCC parameters. To optimize comparability, only the specific methods and protocols that were specified in the ALAAP Supplemental RI QAPP (SAIC 1995b), as required by the *USATHAMA Quality Assurance Program, PAM 11-41* (January 1990), were used to collect and analyze samples during the Supplemental RI. By using consistent sampling and analysis procedures, all data sets were comparable within the study areas at ALAAP, among study areas at the installation, or among U.S. Army facilities nationwide, to ensure that remedial action decisions and priorities were based on a consistent database. Based on the precision and accuracy assessment presented previously, the data collected during the Supplemental RI are considered to be comparable with the data collected during previous investigations.

Completeness—Completeness is defined as the percentage of valid data obtained from the sampling and analysis process. Furthermore, project completeness is defined as the percentage of data used to prepare a preliminary human health-based risk evaluation and on which recommendations for site remediation are based. For analytical data to be considered usable for the preliminary risk evaluation and remediation recommendations, each data point must be satisfactorily validated. Results that have been flagged for various reasons may be considered to have encountered minor problems with limited impact on the data quality. The completeness of both laboratory analyses and sampling are evaluated for each study area. DQOs for the Supplemental RI at ALAAP were set at 95 percent for both field sampling and laboratory completeness. Based on the evaluation of the field and laboratory QC results presented in Sections I.2, I.3, I.5, and I.6 of Appendix I, 98.3 percent of the total environmental sample data collected during the ALAAP Supplemental RI was used as the basis for all recommendations presented in this report.

4.2.1.2 Field Surveillance

A system surveillance of field site activities was completed by an SAIC technical surveillance team in June 1995. This surveillance consisted of a review of field practices at the ALAAP facility and included observing personnel performing tasks, interviewing personnel, and

reviewing the documentation maintained onsite. After the audit was completed, any deficiencies were discussed with the field staff and corrections were identified. All field activities were found to be in compliance with the work plans and applicable USAEC, EPA, and State documents.

4.2.2 Laboratory Data

The following sections describe the laboratory data quality assessment, detection, and quantitation limits, and surveillance of laboratory activities.

4.2.2.1 Laboratory Data Quality Assessment

The following sections summarize the laboratory DQOs for the PARCC parameters obtained during the Supplemental RI at ALAAP. Appendix I contains a detailed discussion of the laboratory PARCC parameters.

Precision—Precision was evaluated based on the analysis of three different types of QC samples: USAEC Class 1, 1A, and 1B spiked QC samples; MS/MSDs; and duplicate field sample analyses.

Class 1, 1A, and 1B USAEC QC spike sample recoveries were used as a primary control of accuracy and precision in the laboratory system. Data were not qualified by the USAEC Geology and Chemistry Branch when there was an indication that either accuracy or precision was less than, higher than, or different than that which was expected. Data were qualified as rejected when significant errors were identified. Rejected data may not be expected to be representative, but may be useful in making broad observations and conclusions.

When USAEC QC spike samples have recoveries outside the upper control limits (UCLs) or lower control limits (LCLs), a lack of precision and accuracy may be suspected. Low and high recoveries of the USAEC QC spike samples indicate that the analytical process is not performing at an optimal level, and may lead to the reporting of false negatives or false positives. A false positive is an analyte that is detected during chemical analysis of a sample, but is not actually present in an environmental sample. Analytes reported at their CRLs that are actually present in an environmental sample are considered false negatives.

The data qualifiers (e.g., I, J, K, L, M, N, O, and P) were applied for USAEC QC low and high spike recoveries being outside the UCLs or LCLs. The qualifier "?" was automatically set when a lot file had been loaded, but the corresponding control charts had not been approved. SVOC, zinc, heptachlor, and 2-amino-4,6-dinitrotoluene (2-A-4,6-DNT) results in selected samples were qualified as rejected (i.e., "R") for USAEC QC spike recoveries being too low or too high. These results were not included in the risk assessment. Table I-4 in Appendix I summarizes the data qualifiers applied to the RI data by the USAEC Geology and Chemistry Branch.

The second type of QC sample used to assess the precision of the data quality was the RPDs of the MS/MSD samples. Ten RPD values (of 66 values reviewed) for SVOC MS/MSD biota analyses and 19 RPD values (of 56 values reviewed) for metals MS/MSD biota analyses did not meet the control criteria. These results are considered to have little impact on the environmental data quality and considered more likely to be the result of the biota matrix variability because all other required analytical QC criteria were met. Fourteen pesticide/PCB MS/MSD RPDs (of 42 values reviewed) were higher than the target limit. The pesticide/PCB MS/MSD recoveries also are outside the control limits, indicating that the bias to the sample data is high. Six RPDs in water and 12 RPDs in soil did not meet the required metals RPD QC criteria. These results do not indicate a QC problem and are not considered to affect the environmental data quality adversely. Three soil hexavalent chromium RPD values (of 13 reviewed values) were greater than the 20 percent criteria. The fact that both high and low recoveries and high RPDs were observed for hexavalent chromium indicates that a matrix effect may be present. These results are not considered to affect the soil data quality adversely because laboratory control samples (LCSs) were within the acceptance criteria. Therefore, the analytical precision DQO for metals and hexavalent chromium analyses is considered to have been met. All PAH, explosives, hexavalent chromium (i.e., water and biota), nitrate, and total phosphate RPD values were within the applicable control limit; therefore, the analytical precision DQO for those analyses is considered to have been met. Sections I.3 and I.5 of Appendix I discuss the analytical QC criteria used to evaluate analytical precision and all MS/MSD results.

Accuracy—Analytical accuracy for this project was measured through the use of method blanks; Class 1, 1A, and 1B USAEC spiked QC samples (low and high spike recoveries); surrogate spiked QC samples (only gas chromatography/mass spectrometry [GC/MS]); surrogate field samples (only GC/MS); and MS/MSD samples.

During the ALAAP Supplemental RI analytical program, one method blank analysis was conducted with each analytical lot of environmental samples analyzed. Each method blank was evaluated for interferents that might interfere with accurate quantification of a target compound. An IRDMIS code flag "B" was applied to numerous acetone, methylene chloride, toluene, chloroform, and B2EHP concentrations detected in soil, water, and biota samples to indicate that these compound concentrations did not exceed 5 to 10 times the concentrations detected in the associated method blanks. The "-" flag indicates those samples whose concentrations are considered to be site related. A flagging code "B" also was applied to aluminum, arsenic, antimony, chromium, copper, lead, zinc, and nickel concentrations detected in biota samples. The flagged analytical results may be considered false positives due to cross contamination during sample collection or from the laboratory equipment. Despite the flagging codes, these QC results are not considered to have affected the sample data quality adversely. Based on an evaluation of the compounds and elements detected in the method blanks, the overall accuracy is acceptable, except where noted. As a result, the laboratory DQO for accuracy is considered to have been met. Sections I.3 and I.5 of Appendix I present a comprehensive discussion of the

method blank results. Table I-4 summarizes the data flags and qualifiers that have been applied to the data.

The USAEC QC control charts show that all analyses had acceptable accuracy, except for 15 lots. Standards, daily calibration, and check standards for these lots were within the control limits. These out-of-control situations in the control charts should have minimal impact on the corresponding data. The field sample data may be quantitated slightly low.

Based on an evaluation of all biota LCS analyses, the percent recoveries of all spike compounds were within acceptable limits, except aluminum and selenium from sample delivery groups (SDGs) ET7964, ET7984, and ET811; lead, aluminum, and zinc from SDG ET8649; and chromium and selenium from SDG T11130. Nickel in the LCS from SDG ET8649 exhibited a very high percent recovery. The percent recoveries outside the control limits indicate the potential for bias to the sample data.

The fourth type of QC used to assess the accuracy of the data quality was the percent recoveries of the surrogates spiked into environmental samples for VOC, SVOC, organochlorine pesticide/PCB, PAH, and TPH-diesel analyses. Based on the pervasive low surrogate spike recoveries for VOCs and SVOCs, soil and water results may be biased low and may include false negatives. Twenty-nine (of 320 reviewed values) organochlorine pesticides/PCBs were outside the applicable control limits. All PAH and TPH (i.e., diesel range organics [DRO]) surrogate recoveries were within the control limits. All supporting VOC, SVOC, organochlorine pesticide/PCB, PAH, and TPH-DRO information cited previously also was qualitatively evaluated with respect to the analytical accuracy DQO.

Although USAEC QC spike samples measure the accuracy of the methods independently of the sample matrix (i.e., the LCS matrix is not the same as the environmental sample), accuracy determined by MS/MSD samples for non-USAEC methods is a function of both matrix and method. Antimony, arsenic, and lead concentrations above the CRLs in selected biota samples may lead to high-biased results, and concentrations below the CRLs may lead to low-biased results due to low MS recoveries. Forty-four inductively coupled argon plasma (ICAP) recoveries (12 water and 32 soil) and 4 ICAP/MS recoveries in soil exceeded the metals QC limits due to possible matrix interferences. All other soil and water parameters that required MS/MSD sample analysis (i.e., hexavalent chromium [water], nitrate, PAHs, pesticides/PCBs [soils] and total phosphate) had recoveries that were within the appropriate control limits. Based on the evaluation of the MS/MSD results and the associated laboratory QC results summarized in Sections I.3 and I.5 of Appendix I, on a project-wide basis, the laboratory accuracy has been determined to be acceptable for all analyses, and as such, the analytical DQO for accuracy was met, except where noted.

Representativeness—Factors that affect the representativeness of the analytical data include improper preservation, holding times, use of standard analytical methods, and matrix or

analyte interferences. Holding times and preservation criteria are based on the most restrictive holding times recommended by USAEC and/or EPA for water and soil matrices.

Based on the evaluation of the factors described previously and summarized in Sections I.3 and I.5 of Appendix I, the samples collected during the Supplemental RI are considered to be representative of the environmental condition at ALAAP.

Comparability—To optimize comparability, only the specific methods and protocols that were specified in the ALAAP Supplemental RI QAPP (SAIC 1995b), as required by the *USATHAMA Quality Assurance Program, PAM 11-41* (January 1990), were used to collect and analyze samples during the Supplemental RI. By using consistent sampling and analysis procedures, all data sets were comparable within the study areas at ALAAP, among study areas at the installation, or among U.S. Army facilities nationwide, to ensure that remedial action decisions and priorities were based on a consistent database. Comparability also was ensured by the analysis of USAEC and EPA reference materials, establishing that the analytical procedures used were generating valid data. The Supplemental RI used one laboratory to perform the USAEC analyses and the same sampling method for each medium. All samples collected for VOCs, SVOCs, PCP, pesticides/PCBs, explosives and explosives breakdown products, metals, nitrate, and total phosphate were analyzed using USAEC Class 1, 1A, and 1B methods. Soil samples collected for TPH, TOC, hexavalent chromium, nitrate, and total phosphate analysis; water samples collected for hexavalent chromium, TPH, and TOC; and biota samples collected for explosives and explosives breakdown products, SVOCs, pesticides/PCBs, hexavalent chromium, and metals were analyzed using EPA solid waste methods and general chemical methods. Based on the precision and accuracy assessment presented previously, the data collected during the Supplemental RI are considered to be comparable with the data collected during previous investigations.

Completeness—Completeness was defined as the percentage of valid data obtained from the sampling and analysis process. Section 4.2.1.1 presents a discussion of completeness for project-related data.

4.2.2.2 Detection and Quantitation Limits

To ensure maximum confidence in chemical identification and detection levels, the CRL was used for reporting all of the target chemicals analyzed by the USAEC methods. The CRL is the lowest sample concentration that may be reported. The CRL is associated with the entire method and reflects all sample preparation and measurement steps. The method CRL is higher than the instrument detection limit (IDL). The CRLs were determined from a comparison of detected versus actual concentrations for spiked standard matrix samples and calculated according to the USATHAMA reporting limit program with a 95 percent confidence limit. The method detection limit (MDL) was used as a minimum level for reporting all of the target chemicals analyzed by the EPA SW846 Methods. The MDL is defined as the minimum

concentration of a chemical that can be measured and reported with 99 percent confidence that the value is above zero. The MDL actually achieved in a given analysis will vary depending on instrument sensitivity and matrix effects.

4.2.2.3 Laboratory Surveillance

A system surveillance of laboratory activities conducted in March 1995 (ESE) and September 1995 (PACE) was completed by an SAIC technical surveillance team. This surveillance consisted of a review of laboratory practices and included observing personnel performing tasks, interviewing personnel, and reviewing the documentation maintained onsite. After the audit was completed, any deficiencies were discussed with the laboratory staff and corrections were identified. All laboratory activities were found to be in compliance with the work plans and applicable USAEC, EPA, SAIC, and State documents.

4.2.3 Assessment Summary

The ALAAP Supplemental RI Phases 1, 2, 3, and 4A field activities spanned 36 months. During the project, more than 1,000 samples were collected, resulting in an analytical database of more than 6,500 analyses. The mass of results of organics and inorganics from ESE, PACE, and EA were usable and fulfilled the needs of the Supplemental RI. A complete discussion of data quality and usability for soil, sediment, water, and biota is provided in Appendix I. Overall, the quality of the analytical data is acceptable. Any limitations affecting data interpretation and usage are summarized below:

- Acetone, methylene chloride, chloroform, carbon disulfide, toluene, MEK, B2EHP, indeno(1,2,3-cd)pyrene, potassium, selenium, copper, and zinc detects in specific samples are highly suspect and should be considered potential false positives due to cross-contamination during sample collection or from the laboratory environment.

- Antimony, arsenic, and lead concentrations above the CRLs in selected biota samples may be high-biased results and concentrations below the CRLs may be low-biased results due to low MS.

- VOC and SVOC data may be biased due to surrogate recoveries outside the LCLs and UCLs.

- SVOC, zinc, heptachlor, and 2-A-4,6-DNT results in selected samples were rejected for the USAEC QC spike recoveries being too low or too high.

4.3 IDENTIFICATION OF CHEMICALS EXCEEDING BACKGROUND

Environmental and biota samples were collected to characterize background conditions at Area B. The background data are compared to data from the study areas to evaluate the presence

of environmental contamination. This section describes the methods used to compare study area data to background data. Data used to determine background conditions include samples collected by SAIC to support this Supplemental RI and background surface soils collected by ESE in 1993 (ESE 1995). Data used in the background comparison have been analyzed and validated in accordance with USAEC protocols (USAEC 1995a, USATHAMA 1990), with one exception. Metals data for background soil samples collected by ESE were validated against EPA SW846 Method Criteria (Methods 6010 and 8330). These data previously have been accepted as valid by EPA.

The background comparison was conducted for each analyte and study area, and follows EPA Region IV guidance (EPA 1995c). **Figure 4-11** presents a flow chart of the methodology for comparing concentrations of chemicals detected to background concentrations. Chemicals may be eliminated from further consideration or identified as exceeding background. Duplicate samples are considered to be QA/QC samples that were collected to assess variability in the sampling process. Consequently, analytical results for duplicates were excluded from use in identification of chemicals exceeding background (CEBs) and statistical analysis.

CEBs were identified for each study area and medium as follows:

- If an analyte was not detected in the study area and medium, it was eliminated as a CEB.
- If an analyte was not detected, or was flagged with an "A," "B," "G," "A+," "B+," "G+," "I," or "U" code, the analyte was used in the CEB comparison and other statistical analyses at a value equal to one-half the reporting limit.
- If the analyte is an organic compound, it was identified as a CEB because background concentrations of organic chemicals are assumed to be zero.
- If the analyte is inorganic, a background comparison was conducted in accordance with EPA Region IV guidance (EPA 1995c). For this comparison, the maximum detected study area concentration was compared to two times the average background concentration. If the study area maximum equaled or exceeded the background criterion, the analyte was identified as a CEB.

Chemicals identified as CEBs are included in the evaluation of the nature and extent of contamination (Section 4), and are the first step in developing the list of chemicals of concern (COCs). The CEBs are discussed with respect to fate and transport (Section 5) and carried forward to the human health (Section 6) and ecological risk assessments (Section 7). The potential impact of the CEBs on human health or the environment is determined by conducting human health and ecological risk assessments.

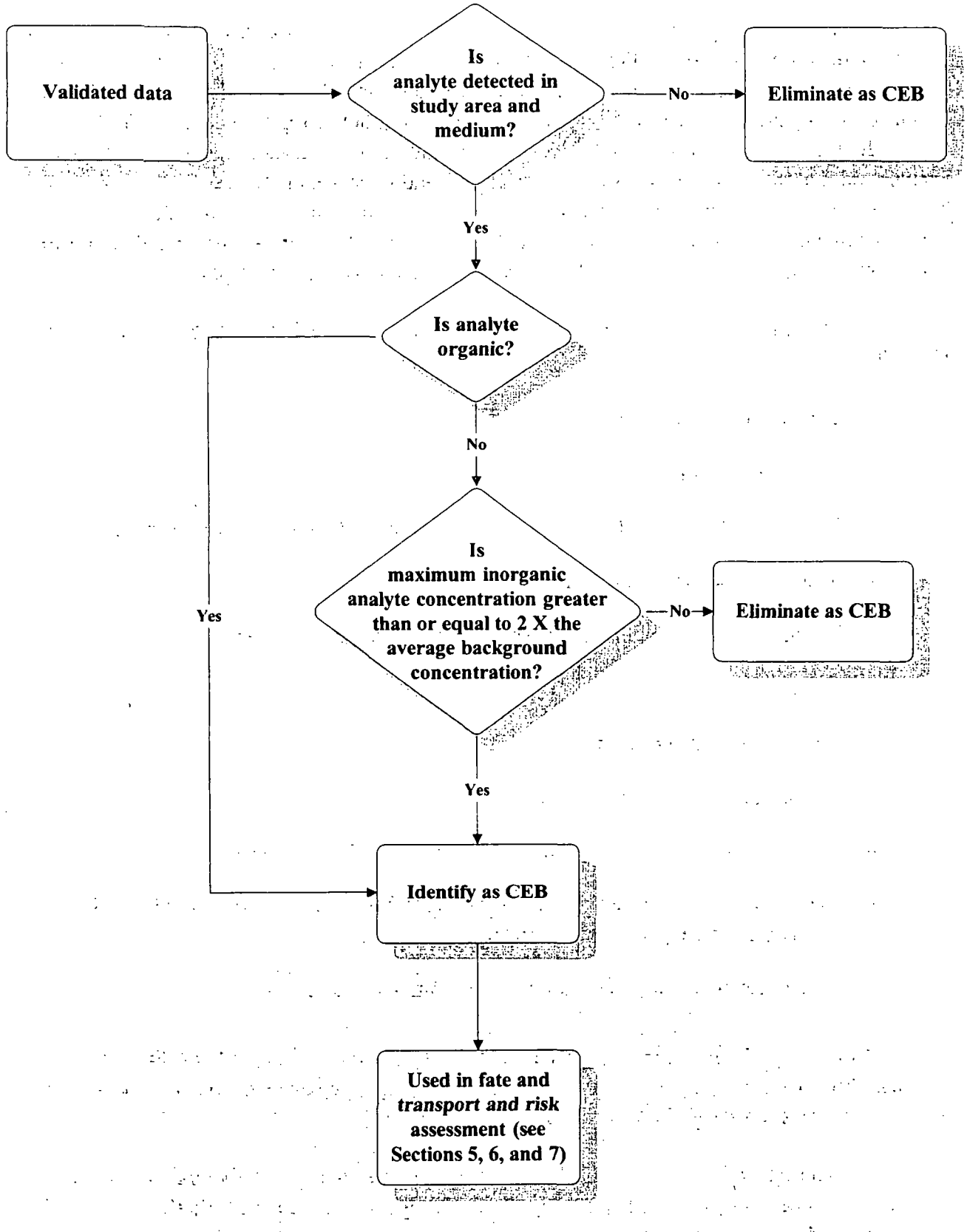

Figure 4-11. Comparison of Study Area Concentrations to Background

For soil, groundwater, surface water, sediment, and biota, background results for each analyte were compared to study area results (Sections 4.4 through 4.8). Background comparisons were conducted separately for soils for three distinct soil intervals. The initial comparison was conducted using study area and background data for surface soil samples obtained from 0 to less than 1 foot BLS. The second and third comparisons were conducted using study area and background data for soils collected from 1 to 10 feet and greater than 10 feet BLS, respectively. These depths were chosen to distinguish between surface, shallow subsurface, and deep subsurface soil contamination and because data used in the risk assessment are aggregated according to these depths (see discussion in Section 6.1.2.1 concerning aggregation of data by depth).

For each medium and study area, summary statistics are provided in tabular format for each CEB. These tables include:

- Total number of samples analyzed for each analyte
- Total number of times the analyte was detected
- Frequency of detection (number of detects divided by total number of samples)
- Minimum and maximum CRL
- Minimum and maximum detected concentrations for each analyte
- Arithmetic mean
- Standard deviation of the mean
- Assumed distribution of the data
- 95 percent upper confidence limit (UCL_{95}) of the arithmetic mean
- The exposure point concentration, which is the concentration used in the risk assessment and explained in Section 6
- Two times the average background concentration for metals.

Tables identifying sampling points within each study area and media where the concentration exceeds the background criteria (i.e., two times the average background concentration) are presented in Appendix J.

An analysis of variance (ANOVA) was conducted to support the nature and extent evaluation and the weight of evidence analysis, which supports decision-making (Section 8). For the nature and extent evaluation, CEBs were subjected to an ANOVA. CEBs identified as site related in the ANOVA are the chemicals on which the text is focused in Sections 4.4 through 4.8.

The ANOVA is used as one factor in the weight of evidence discussion (Section 8), which is presented to help make risk management decisions regarding the need for remediation.

ANOVA includes a wide variety of statistical procedures that compare the means of different groups of observations to determine whether any significant differences exist among the groups. For the Supplemental RI, ANOVA was conducted using the Mann-Whitney test. The Mann-Whitney test is a nonparametric test that uses the ranks of the sample data rather than their values. The underlying assumption of the Mann-Whitney test is that the ranks of the data are approximated by a normal distribution. The minimum number of samples required for conducting the Mann-Whitney test was four. The Mann-Whitney test was not conducted for study area or background data sets with fewer than four samples. The methodology used to conduct ANOVA is discussed further in Appendix J.

Sections 4.4 through 4.7 discuss the horizontal and vertical extent of CEBs, where appropriate. Although all CEBs are provided in the sections, the discussions focus on those CEBs that also were determined to exceed background based on the ANOVA analysis. For groundwater and surface water, essential nutrient (calcium, magnesium, potassium, and sodium) CEBs are discussed because these nutrients can be indicators of water quality. For soil and sediment, essential nutrient CEBs are presented in the text, but horizontal and vertical extent is not discussed. Section 4.8 discusses CEBs for biota samples collected during the Supplemental RI.

4.4 GROUNDWATER QUALITY ASSESSMENT

The chemical quality of groundwater underlying ALAAP – Area B is affected by natural groundwater interaction with the aquifer through which it flows in addition to the effects of chemical constituents that are the result of prior munitions production and storage operations. The following sections summarize inorganic and organic constituents detected in background groundwater samples and environmental samples collected from wells monitoring Area B between January 1995 and January 1997 (Phases 1, 2, and 3). The investigation of groundwater quality in deeper bedrock pathways (Phase 4) that are associated with conduit flow is continuing at the site. The locations of monitoring wells installed in Area B are shown in Sheet 3-5.

4.4.1 Background Groundwater Quality

Ten monitoring wells within and around the ALAAP boundary that are indicative of background groundwater quality were sampled during the Area A and Area B investigations. These included monitoring wells installed north and east of Area A (P-83, P-84, P-85, P-87, P-91, D-20, D-22, and D-23) and GW-BK-02BR. Source water from the Childersburg, Alabama, water supply well, which produces from deeper bedrock, also was sampled and used for background comparison. Five of the monitoring wells are completed in the shallow residuum (P-83, P-84, P-85, P-87, and P-91) and five of the monitoring wells were installed in the bedrock (D-20, D-22, D-23, GW-BK-02BR, and the potable Childersburg supply). Each background well is off the post,

upgradient of ALAAP, and is not considered to be affected by the investigated sites in Area A or Area B. The background wells north and west of Area A, are upgradient of the investigated sites in Area A, as documented by groundwater elevation maps (ESE 1996). Groundwater at residuum background well GW-BK-01 has been compromised consistently by explosives concentrations and groundwater in well P-86 contains elevated metals, including lead. These wells were excluded from the background data set. All groundwater samples collected from the wells during the Area B investigations were analyzed for metals, explosives, VOCs, and SVOCs. Samples collected during the Area A investigation were analyzed for explosives and metals. Organic constituents that were detected in background groundwater samples include VOCs, SVOCs, including trace concentrations of PAHs, and sporadically detected explosives compounds. **Table 4-5** provides summary statistics for the background groundwater samples collected. Data summary tables are presented in Appendix K.

Metals—Aluminum (104 to 2,930 µg/L), arsenic (1.38 to 2.65 µg/L), barium (6.13 to 63.2 µg/L), chromium (6.17 to 12.4 µg/L), copper (10.7 to 11.6 µg/L), iron (51 to 8,240 µg/L), lead (1.26 to 10.1 µg/L), manganese (6.56 to 241 µg/L), selenium (1.28 to 2.17 µg/L), vanadium (14.4 µg/L), and zinc (24.8 to 375 µg/L) were detected in the background wells. Concentrations of nutrient metals that were detected in the background wells included calcium (1,560 to 76,300 µg/L), magnesium (579 to 17,100 µg/L), potassium (644 to 25,800 µg/L), and sodium (1,540 to 8,090 µg/L). The detected metals concentrations in background groundwater samples are predominantly within the ranges determined by Moser (1988) for natural groundwater quality from Knox Group wells in Talladega County. Background concentrations of aluminum, copper, and vanadium in Talladega County were not reported by Moser. Concentrations of calcium (76,300 µg/L), chromium (6.17 to 12.4 µg/L), iron (975 to 8,240 µg/L), manganese (241 µg/L), and potassium (3,340 to 25,800 µg/L) that were detected in the background wells exceeded the regional ranges reported by Moser. A comparison of the metals concentrations detected in background samples at ALAAP to naturally occurring concentrations in Talladega County is included in Table 4-5.

Explosives—Explosives compounds and explosives breakdown products were detected in wells P-83, P-84, D-20, and GW-BK-02BR. The explosives compounds in the background wells were not detected consistently between sampling events, and consisted of 2,4,6-trinitrotoluene (TNT) (0.769 to 22.9 µg/L), 2,4-DNT (0.576 to 120 µg/L), 2,6-DNT (1.48 µg/L), and 2-A-4,6-DNT (0.234 µg/L). The maximum concentration for all explosives compounds was detected in background well D-20.

Volatile Organic Compounds—VOCs, including acetone (80 µg/L), toluene (0.59 to 3 µg/L), and trichloroethene (TCE) (0.79 µg/L), were detected in the background wells for Area B. The VOCs were detected in background wells D-20, P-83, and P-84 and generally were not reproduced between sampling events.

Table 4-5. Summary Statistics and Exposure Point Concentrations for Groundwater at Study Area BK - Background
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 12:20:55 PM
Run Date: 3/31/99
Exposure Unit: BK_WD1

Parameter	Units	Proportion of Detects - All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	ALAAP (SAIC, 1999) NonDetects Min CRL[c]	Max CRL[c]	Detects Minimum	Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Talladega County (Moser, 1988) Minimum	Maximum	Arithmetic Mean	Standard Deviation
Aluminum	µg/L	11 / 14	8 / 9	89%	141	141	104	2,930	744	897	NR	NR	NR	NR
Arsenic	µg/L	3 / 16	2 / 10	20%	1.00	2.5	1.4	2.7	1.2	0.54	<0.01	3.0	1.17	0.57
Barium	µg/L	14 / 14	9 / 9	100%	--	--	6.1	63	18	8.8	10	110	15.75	16.93
Calcium	µg/L	14 / 14	9 / 9	100%	--	--	1,560	76,300	23,203	11,339	1400	60,000	33,010	10,650
Chromium	µg/L	5 / 14	5 / 9	56%	6.0	7.0	6.2	12	5.6	3.3				
Copper	µg/L	2 / 14	2 / 9	22%	5.0	8.1	11	12	4.5	1.2	NR	NR	NR	NR
Iron	µg/L	12 / 14	8 / 9	89%	37	39	51	8,240	1,704	2,575	10	900	114.39	194.65
Lead	µg/L	8 / 17	4 / 10	40%	1.00	1.3	1.3	10	1.9	1.7	<1	20.0	2.32	3.62
Magnesium	µg/L	14 / 14	9 / 9	100%	--	--	579	17,100	10,207	4,840	1200	25,000	14,470	4,660
Manganese	µg/L	10 / 14	7 / 9	78%	2.5	2.8	6.6	241	56	75	5	170	31.77	46.69
Potassium	µg/L	14 / 14	9 / 9	100%	--	--	644	25,800	5,113	4,495	200	2,200	690	470
Selenium	µg/L	2 / 16	2 / 10	20%	1.00	3.0	1.3	2.2	1.2	0.37	<1	10.0	2.69	1.91
Sodium	µg/L	13 / 14	9 / 9	100%	--	--	1,540	8,090	3,325	2,101	700	12,000	23,600	2,330
Vanadium	µg/L	1 / 14	1 / 9	11%	4.7	11	14	14	6.1	3.2	NR	NR	NR	NR
Zinc	µg/L	4 / 14	2 / 9	22%	21	36	25	375	30	44	<5	1100	104.34	198.67
2,4,6-Trinitrotoluene	µg/L	4 / 17	4 / 10	40%	0.64	0.64	0.77	23	1.4	2.4				
2,4-Dinitrotoluene	µg/L	5 / 18	4 / 10	40%	0.064	4.5	0.58	120	6.4	13				
2,6-Dinitrotoluene	µg/L	1 / 18	1 / 10	10%	0.074	0.79	1.5	1.5	0.094	0.15				
2-Amino-4,6-Dinitrotoluene	µg/L	1 / 11	1 / 5	20%	0.16	0.16	0.23	0.23	0.095	0.035				
Acenaphthylene	µg/L	1 / 8	1 / 5	20%	0.50	1.4	2.6	2.6	0.99	0.92				
Acetone	µg/L	1 / 7	1 / 5	20%	13	13	80	80	14	16				
Benzo(b)fluoranthene	µg/L	1 / 8	1 / 5	20%	0.0014	5.4	0.0017	0.0017	0.27	0.60				
Benzo(k)fluoranthene	µg/L	2 / 8	2 / 5	40%	0.00038	0.87	0.00053	0.00074	0.044	0.097				
Benzoic Acid	µg/L	1 / 8	1 / 5	20%	13	13	26	26	8.5	4.4				
Benzyl Alcohol	µg/L	2 / 8	2 / 5	40%	0.72	0.72	1.3	1.7	0.68	0.45				
Dibenzo(a,h)anthracene	µg/L	1 / 8	1 / 5	20%	0.0025	6.5	0.0040	0.0040	0.33	0.73				
Fluoranthene	µg/L	1 / 8	1 / 5	20%	0.0034	3.3	0.0048	0.0048	0.33	0.74				
Indeno(1,2,3-cd)pyrene	µg/L	2 / 8	1 / 5	20%	0.0025	8.6	0.0077	0.020	0.43	0.96				
Nitrate	µg/L	2 / 2	2 / 2	100%	--	--	457	532	495	--				
Pentachlorophenol	µg/L	1 / 8	1 / 5	20%	0.020	18	16	16	3.7	3.2				
Phenol	µg/L	4 / 8	3 / 5	60%	9.2	9.2	35	300	61	64				
Toluene	µg/L	3 / 7	2 / 5	40%	0.50	2.0	0.59	3.0	1.1	1.1				
Total Organic Carbon	µg/L	2 / 2	2 / 2	100%	--	--	1,650	2,290	1,970	--				
Total phosphates	µg/L	1 / 1	1 / 1	100%	--	--	15	15	15	--				
Trichloroethene	µg/L	1 / 7	1 / 5	20%	0.50	2.0	0.79	0.79	0.38	0.18				
bis(2-Ethylhexyl)phthalate	µg/L	4 / 8	3 / 5	60%	4.8	19	7.2	41	11	9.7				
di-N-Butyl Phthalate	µg/L	1 / 8	1 / 5	20%	3.7	3.7	3.5	3.5	2.2	0.74				

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
NR = Not reported.
Organic constituents not analyzed by Moser, 1998.

Semivolatile Organic Compounds—Benzoic acid (26 µg/L); benzyl alcohol (1.3 to 1.7 µg/L); B2EHP (7.2 to 41 µg/L); di-N-butyl phthalate (3.5 µg/L); PCP (15.7 µg/L); phenol (35 to 300 µg/L); and the PAH compounds acenaphthylene (2.6 µg/L), benzo(b)fluoranthene (0.0017 µg/L), benzo(k)fluoranthene (0.00053 to 0.00074 µg/L), dibenzo(a,h)anthracene (0.004 µg/L), fluoranthene (0.0048 µg/L), and indeno(1,2,3-cd)pyrene (0.0077 to 0.02 µg/L) were sparsely detected in the background wells D-20, P-83, P-84, and GW-BK-02BR.

4.4.2 Area B Groundwater Quality

Because of the location of an interpreted groundwater divide extending into Area A, the assessment of groundwater quality underlying Area B is separated into two site areas. The first site area incorporates the majority of the Industrial/Storage Area located west of the groundwater divide and the second site area includes Study Areas 16, 19, and 22 located east of the inferred divide. Additional investigations pertaining to the presence and migration of groundwater contamination are currently ongoing (Phase 4) and will be presented in a separate groundwater report. The results for select chemicals (TNT, 2,4-DNT, 2,6-DNT, and lead) detected during the Phase 1, 2, and 3 groundwater sampling events are shown on **Sheets 4-1** to **4-4**.

4.4.2.1 Area B Industrial/Storage Area

Groundwater underlying the majority of Area B north and west of the groundwater divide contains a mixture of naturally occurring and potentially site-related inorganic constituents and organic chemicals, including VOCs, SVOCs, and explosives-related compounds. Appendix K presents data summary tables for the groundwater. **Table 4-6** provides summary statistics for elements and compounds detected in Area B groundwater for sampling events that were conducted between January 1995 and January 1997.

Chemical concentrations that were attributable to site background or are naturally occurring, and, therefore, are not indicative of mission-related environmental contamination, are not considered further in delineating the nature and extent of the chemical constituents impacting groundwater quality at Area B. Although many of these compounds are not considered in the physical delineation of groundwater contamination, the detected concentrations remain subject to risk assessment.

Metals—Inorganic constituents that were detected above background concentrations in groundwater underlying the Industrial/Storage Area in Area B are shown in the box adjacent to this paragraph and included aluminum (73.6 to 76,700 µg/L), antimony (1.0 to 3.04 µg/L), arsenic (0.99 to 200 µg/L), barium (4.69 to 1,430 µg/L), beryllium (5.62 to 6.83 µg/L), chromium (6.12 to 92.6 µg/L), hexavalent chromium (20 µg/L), cobalt (29 to 155 µg/L), copper (6.14 to 891 µg/L), iron (51.4 to 163,000 µg/L), lead (1.02 to 65,000 µg/L), manganese (3.72 to 6,420 µg/L), mercury (0.439 to 0.506 µg/L), nickel (7.87 to 138 µg/L), selenium (1.11 to 3.66 µg/L), thallium (1.02 to

Table 4-6. Summary Statistics and Exposure Point Concentrations for Groundwater at Main Industrial Area - Main Industrial Area
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 7:13:38 PM
Run Date: 3/29/99
Exposure Unit: GWB1WD1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[g]	Background Comparison[g]
Aluminum	µg/L	91 / 112	76 / 90	84%	141	141	74	76,700	4,687	11,687	Lognormal	9,028	9,028		1,487	[CEB][ANOVA]
Antimony	µg/L	7 / 112	7 / 90	8%	1.00	1.00	1.0	3.0	0.59	0.40	Lognormal	0.61	0.61		--	[CEB]
Arsenic	µg/L	49 / 112	43 / 90	48%	1.00	1.00	0.99	200	4.8	21	Lognormal	3.7	3.7		2.4	[CEB][ANOVA]
Barium	µg/L	112 / 112	90 / 90	100%	--	--	4.7	1,430	66	168	Lognormal	69	69		36	[CEB][ANOVA]
Beryllium	µg/L	2 / 112	2 / 90	2%	5.0	5.0	5.6	6.8	2.6	0.56	Lognormal	2.6	2.6		--	[CEB]
Calcium	µg/L	112 / 112	90 / 90	100%	--	--	570	750,000	39,335	83,973	Lognormal	63,808	63,808		46,406	[CEB][ANOVA]
Chromium	µg/L	22 / 112	21 / 90	23%	6.0	7.0	6.1	93	8.1	17	Lognormal	7.2	7.2		11	[CEB][ANOVA]
Cobalt	µg/L	9 / 112	8 / 90	9%	25	50	29	155	19	19	Lognormal	20	20		--	[CEB]
Copper	µg/L	19 / 112	17 / 90	19%	5.0	8.1	6.1	891	19	95	Lognormal	11	11		9.0	[CEB][ANOVA]
Hexavalent Chromium	µg/L	1 / 9	1 / 9	11%	10.0	10.0	20	20	6.7	5.0	Lognormal	9.3	9.3		--	[CEB]
Iron	µg/L	107 / 112	87 / 90	97%	39	39	51	163,000	7,635	21,976	Lognormal	14,173	14,173		3,409	[CEB][ANOVA]
Lead	µg/L	121 / 166	74 / 90	82%	1.00	1.3	1.0	65,000	269	2,286	Lognormal	45	45		3.7	[CEB][ANOVA]
Magnesium	µg/L	104 / 112	83 / 90	92%	500	1000	514	233,000	12,828	26,243	Lognormal	22,303	22,303		20,413	[CEB][ANOVA]
Manganese	µg/L	108 / 112	88 / 90	98%	2.8	2.8	3.7	6,420	436	963	Lognormal	948	948		112	[CEB][ANOVA]
Mercury	µg/L	3 / 111	2 / 89	2%	0.24	0.24	0.44	0.51	0.13	0.053	Lognormal	0.13	0.13		--	[CEB]
Nickel	µg/L	13 / 112	13 / 90	14%	7.1	34	7.9	138	19	17	Lognormal	23	23		--	[CEB]
Potassium	µg/L	92 / 112	80 / 90	89%	375	2,910	481	94,700	6,606	15,744	Lognormal	7,273	7,273		10,226	[CEB][ANOVA]
Selenium	µg/L	25 / 112	23 / 90	26%	1.00	3.1	1.1	3.7	0.88	0.60	Lognormal	0.96	0.96		2.4	[CEB][ANOVA]
Sodium	µg/L	104 / 112	83 / 90	92%	2,290	2,290	1,140	83,500	6,213	9,967	Lognormal	6,834	6,834		6,651	[CEB][ANOVA]
Thallium	µg/L	3 / 112	3 / 90	3%	1.00	1.00	1.0	1.4	0.52	0.12	Lognormal	0.53	0.53		--	[CEB]
Vanadium	µg/L	17 / 112	16 / 90	18%	4.7	11	8.2	227	13	33	Lognormal	12	12		12	[CEB][ANOVA]
Zinc	µg/L	44 / 112	41 / 90	46%	21	36	23	347	36	49	Lognormal	40	40		61	[CEB][ANOVA]
1,1,1-Trichloroethane	µg/L	2 / 97	2 / 76	3%	0.50	0.50	1.8	2.6	0.28	0.16	Lognormal	0.28	0.28		--	[CEB]
1,3,5-Trinitrobenzene	µg/L	26 / 166	15 / 90	17%	0.45	3.7	0.46	93	1.5	7.6	Lognormal	0.77	0.77		--	[CEB]
1,3-Dinitrobenzene	µg/L	11 / 166	6 / 90	7%	0.61	5.1	1.0	81	0.94	4.3	Lognormal	0.62	0.62		--	[CEB]
2,4,6-Trinitrotoluene	µg/L	59 / 166	42 / 90	47%	0.64	5.3	0.71	26,000	366	2,162	Lognormal	64	64		--	[CEB]
2,4-Dinitrotoluene	µg/L	120 / 166	72 / 90	80%	0.064	1.1	0.082	49,000	1,319	4,689	Lognormal	23,257	23,257		--	[CEB]
2,6-Dinitrotoluene	µg/L	55 / 166	31 / 90	34%	0.074	0.37	0.076	1,700	13	67	Lognormal	7.2	7.2		--	[CEB]
2-Amino-4,6-Dinitrotoluene	µg/L	27 / 147	14 / 90	16%	0.16	1.3	0.17	230	3.7	23	Lognormal	0.81	0.81		--	[CEB]
2-Methylnaphthalene	µg/L	2 / 97	2 / 76	3%	1.3	20	15	53	1.7	6.3	Lognormal	1.2	1.2		--	[CEB]
4-Amino-2,6-Dinitrotoluene	µg/L	15 / 166	8 / 90	9%	1.6	13	1.4	220	4.4	22	Lognormal	2.3	2.3		--	[CEB]
Acenaphthylene	µg/L	5 / 97	5 / 76	7%	0.50	5.0	1.4	45	1.2	5.1	Lognormal	0.86	0.86		--	[CEB]
Acetone	µg/L	20 / 97	20 / 76	26%	13	25	15	44	10	6.4	Lognormal	11	11		--	[CEB]
Anthracene	µg/L	3 / 97	3 / 76	4%	0.089	5.0	0.12	0.75	0.16	0.29	Lognormal	0.19	0.19		--	[CEB]
Benzo(a)anthracene	µg/L	5 / 93	4 / 76	5%	0.0015	20	0.0016	0.017	0.41	1.2	Lognormal	29	0.017	#	--	[CEB]
Benzo(a)pyrene	µg/L	9 / 93	6 / 76	8%	0.0013	50	0.0014	0.040	1.1	3.0	Lognormal	665	0.040	#	--	[CEB]
Benzo(b)fluoranthene	µg/L	12 / 93	9 / 76	12%	0.0016	50	0.0018	0.15	1.3	3.0	Lognormal	602	0.15	#	--	[CEB]
Benzo(g,h,i)perylene	µg/L	12 / 97	11 / 76	14%	0.0040	60	0.0040	0.028	1.6	3.6	Lognormal	258	0.028	#	--	[CEB]
Benzo(k)fluoranthene	µg/L	13 / 93	9 / 76	12%	0.00044	9.0	0.00054	0.035	0.21	0.34	Lognormal	36	0.035	#	--	[CEB]
Benzyl Alcohol	µg/L	1 / 97	1 / 76	1%	0.72	7.0	2.7	2.7	0.43	0.45	Lognormal	0.43	0.43		--	[CEB]
Carbon Disulfide	µg/L	1 / 97	1 / 76	1%	0.50	0.71	0.85	0.85	0.26	0.038	Lognormal	0.26	0.26		--	[CEB]
Carbon Tetrachloride	µg/L	7 / 97	5 / 76	7%	0.58	1.2	0.81	6.4	0.45	0.80	Lognormal	0.43	0.43		--	[CEB]
Chloroform	µg/L	8 / 97	7 / 76	9%	0.50	1.00	0.52	5.1	0.36	0.58	Lognormal	0.35	0.35		--	[CEB]
Chrysene	µg/L	3 / 93	2 / 76	3%	0.031	20	0.13	0.49	0.56	1.2	Lognormal	2.1	0.49	#	--	[CEB]

Table 4-6. Summary Statistics and Exposure Point Concentrations for Groundwater at Main Industrial Area - Main Industrial Area (Continued)
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 7:13:38 PM
Run Date: 3/29/99
Exposure Unit: GWB1WD1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Cyclotetramethylenetetranitramine	µg/L	3 / 166	3 / 90	3%	1.2	12	2.3	10	0.87	0.87	Lognormal	0.90	0.90		--	[CEB]
Dibenzo(a,h)anthracene	µg/L	2 / 93	2 / 76	3%	0.0025	60	0.0039	0.0064	1.5	3.6	Lognormal	570	0.0064	#	--	[CEB]
Ethylbenzene	µg/L	1 / 97	1 / 76	1%	0.50	0.50	20	20	0.38	1.1	Lognormal	0.31	0.31		--	[CEB]
Fluoranthene	µg/L	22 / 97	19 / 76	25%	0.0034	30	0.0034	0.054	0.82	1.8	Lognormal	41	0.054	#	--	[CEB]
Indeno(1,2,3-cd)pyrene	µg/L	13 / 93	12 / 76	16%	0.0025	90	0.0029	0.036	2.1	5.4	Lognormal	631	0.036	#	--	[CEB]
Methylene Chloride	µg/L	2 / 97	2 / 76	3%	2.3	4.7	2.4	2.5	1.2	0.26	Lognormal	1.3	1.3		--	[CEB]
Methylethylketone	µg/L	1 / 97	1 / 76	1%	6.4	6.4	130	130	4.9	15	Lognormal	4.0	4.0		--	[CEB]
N-Nitrosodiphenylamine	µg/L	1 / 97	1 / 76	1%	3.0	30	15	15	1.9	2.2	Lognormal	1.8	1.8		--	[CEB]
Naphthalene	µg/L	8 / 97	7 / 76	9%	0.50	5.0	1.5	41	1.1	4.7	Lognormal	0.72	0.72		--	[CEB]
Nitrobenzene	µg/L	11 / 166	6 / 90	7%	0.65	6.4	1.0	32	1.1	3.7	Lognormal	0.80	0.80		--	[CEB]
Pentachlorophenol	µg/L	7 / 91	6 / 76	8%	1.2	200	1.4	11	5.4	12	Lognormal	8.0	8.0		--	[CEB]
Phenanthrene	µg/L	2 / 97	2 / 76	3%	0.072	5.0	0.27	1.1	0.17	0.31	Lognormal	0.20	0.20		--	[CEB]
Phenol	µg/L	11 / 97	11 / 76	14%	9.2	90	18	52	8.6	11	Lognormal	8.9	8.9		--	[CEB]
Pyrene	µg/L	7 / 97	6 / 76	8%	0.028	30	0.045	1.6	0.76	1.8	Lognormal	4.2	1.6	#	--	[CEB]
RDX	µg/L	4 / 166	3 / 90	3%	1.2	9.7	2.9	24	0.99	1.9	Lognormal	0.93	0.93		--	[CEB]
Tetryl	µg/L	1 / 166	1 / 90	1%	1.6	16	14	14	1.2	1.2	Lognormal	1.2	1.2		--	[CEB]
Toluene	µg/L	22 / 97	21 / 76	28%	0.50	7.6	0.50	6.4	0.62	0.64	Lognormal	0.69	0.69		--	[CEB]
Xylene	µg/L	1 / 97	1 / 76	1%	0.84	0.84	4.5	4.5	0.45	0.23	Lognormal	0.46	0.46		--	[CEB]
Trichloroethene	µg/L	3 / 97	2 / 76	3%	0.50	0.50	0.75	1.3	0.27	0.12	Lognormal	0.28	0.28		--	[CEB]
Vinyl Chloride	µg/L	1 / 97	1 / 76	1%	2.6	2.6	3.5	3.5	1.3	0.25	Lognormal	1.4	1.4		--	[CEB]
bis(2-Ethylhexyl)phthalate	µg/L	5 / 97	5 / 76	7%	4.5	70	5.6	51	6.3	8.7	Lognormal	6.6	6.6		--	[CEB]
m-Nitrotoluene	µg/L	1 / 166	1 / 90	1%	1.4	12	4.2	4.2	0.90	0.63	Lognormal	0.94	0.94		--	[CEB]
o-Nitrotoluene	µg/L	9 / 166	7 / 90	8%	0.41	4.1	0.49	60	0.62	3.1	Lognormal	0.38	0.38		--	[CEB]
p-Nitrotoluene	µg/L	2 / 166	2 / 90	2%	1.1	11	3.2	24	0.87	1.3	Lognormal	0.86	0.86		--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

1.43 µg/L), vanadium (8.2 to 227 µg/L), and zinc (22.6 to 347 µg/L). Maximum inorganics concentrations were detected in wells GW-03-003, D-7B, P-5, GW-18-003, P-44, and D-10. Concentrations of nutrient metals that were detected in the Area B wells and exceeded background included calcium (570 to 750,000 µg/L), magnesium (514 to 233,000 µg/L), potassium (481 to 94,700 µg/L), and sodium (1,140 to 83,500 µg/L).

Maximum Concentrations*	
Analyte	**µg/L**
Aluminum	76,700
Antimony	**3.04**
Arsenic	200
Barium	1,430
Beryllium	**6.83**
Calcium	750,000
Chromium	92.6
Cobalt	**155**
Copper	891
Hexavalent Chromium	**20**
Iron	163,000
Lead	65,000
Magnesium	233,000
Manganese	6,420
Mercury	**0.506**
Nickel	**138**
Potassium	94,700
Selenium	3.66
Sodium	83,500
Thallium	**1.43**
Vanadium	227
Zinc	347

* Metals also determined to exceed background based on ANOVA evaluation are shown in bold.

Consistent with the dissolution of limestone and dolomite from the site aquifer, calcium and magnesium concentrations show a strong positive correlation to each other in the groundwater. Extensive natural sources of trace metals concentrations are available from geologic formations within the Alabama Valley and Ridge Province in Talladega County (Rheams 1992). Mining-grade ores and minerals occur extensively in the undifferentiated Knox Group rocks and residuum, including bauxite and kaolin (aluminum source), limonite and ocher (iron ore), manganese and cobalt-bearing manganese deposits, barite ($BaSO_4$) mineralization (barium source), galena (PbS) and sphalerite (ZnS) mineralization (Rheams 1992).

Lead concentrations were widely detected (73 percent frequency of detection) in groundwater underlying Area B. The spatial distribution of lead in groundwater (**Figure 4-12**) is closely related to the observed distribution of explosives compounds detected in the groundwater, suggesting a common source. Detected lead concentrations extend from the southern portion of ALAAP in the vicinity of Study Areas 17 and 18 toward well P-10 at Study Area 6. The highest lead concentration (65,000 µg/L) was detected at GW-18-003 during the May 1995 sampling round. Based on a comparison of filtered and unfiltered sample analyses, lead (and metals concentrations in general) typically were reduced by field filtration (0.45µ filter). These results indicate that elevated trace metal concentrations may have been enhanced by acid preservation (pH <2) of turbid samples. Lead concentrations in bedrock wells monitoring the Area B Industrial/Storage Area ranged from 4.35 to 94.2 µg/L, exceeding the EPA action level for lead at the tap (15 µg/L) at wells D-7B (94.2 µg/L, GW-20-001BR (25.8 µg/L), and D-6 (17 µg/L). The elevated concentrations were not reproduced by multiple samplings conducted at these wells. Arsenic concentrations that exceed background levels were detected in bedrock (D-6, D-7B, D-9, D-10, D-11, D-13, and GW-20-01BR) and soil wells (P-5, P-10, P-14, P-17, P-35, P-36, P-51, P-66, P-82, GW-02-003, GW-03-001, GW-03-003, GW-04-003, GW-17-003, GW-18-003, and GW-21-002). The highest arsenic concentration in groundwater (200 µg/L at well D-7B) was associated with a turbid sample and was not verified by subsequent sampling in May 1995.

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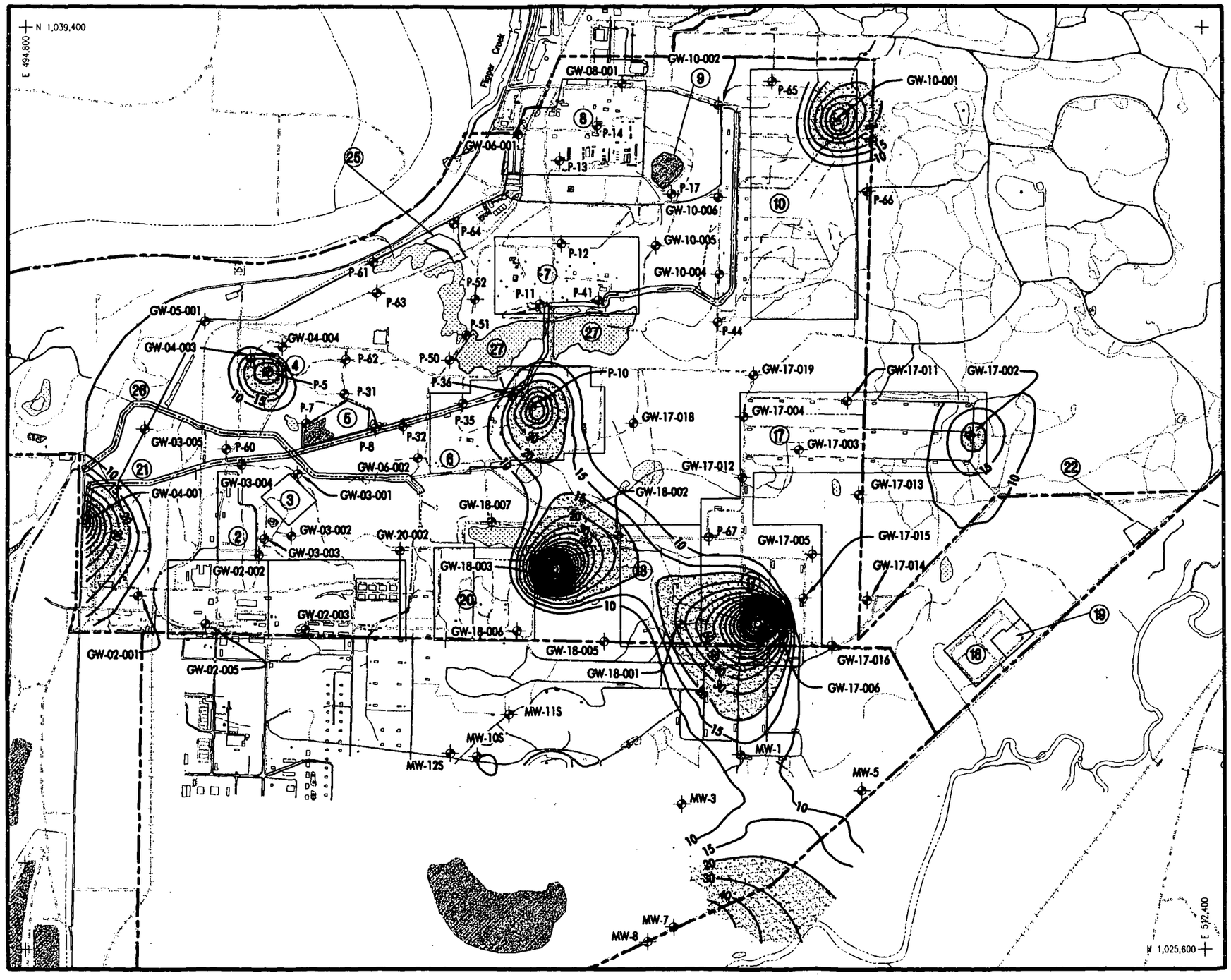


LEGEND:

- BUILDINGS
- PRIMARY ROADS
- SECONDARY ROADS
- TRAILS
- FENCE
- AREA BOUNDARIES
- RAIL ROAD
- CREEK, TRIBUTARIES AND RIVER
- WETLANDS
- PONDS, IMPOUNDMENTS
- GW-16-007 MONITORING WELL
- CONCENTRATION CONTOUR (10 µg/L) INTERVAL
- AREAS EXCEEDING EPA ACTION LEVEL OF OF 15 µg/L FOR LEAD
- GRID BASED ON ALABAMA STATE PLANE EAST

NOTES:

1. BASE MAP OF AREA B RECEIVED FROM AIR SURVEY CORP. MAP COMPILED FROM AERIAL SURVEY FEBRUARY 1995.
2. OUTSIDE AREAS OF BASE MAP RECEIVED FROM AMERICAN DIGITAL CARTOGRAPHY, SCANNED FROM USGS CHILDERSBURG 7.5 QUADRANGLE, 1984, 1" = 100,000'.

STATE PLANE GRID

0 800 1600 3200

SCALE: 1" = 1600'

U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

Lead Concentrations in Groundwater

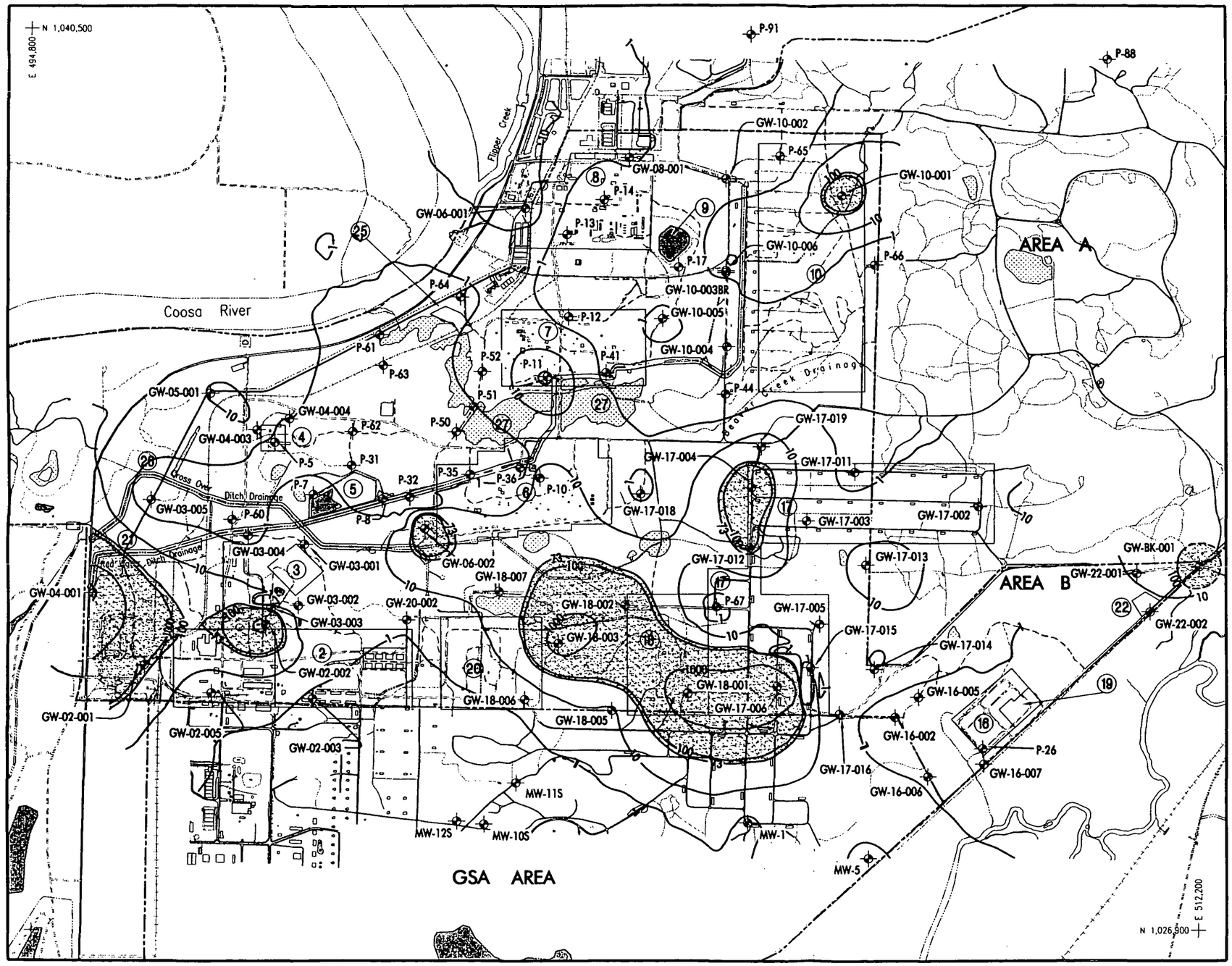
Figure No.	Project No.	File Name	Date
4-12	01-0827-03-8178-045	99015\DWGS\E42LEADC	03-31-99

Maximum Concentrations	
Analyte	µg/L
2,4-DNT	49,000
2,6-DNT	1,700
2-A-4,6-DNT	230
4-A-2,6- DNT	220
TNT	26,000
Nitrobenzene	32.3
1,3-DNB	81
1,3,5-TNB	93
HMX	10.1
RDX	24.1
Tetryl	13.8
m-Nitrotoluene	4.18
o-Nitrotoluene	60
p-Nitrotoluene	23.7

Explosives—The primary constituents impacting groundwater quality underlying Area B are the DNTs and TNT and their derivatives. The maximum concentrations of explosives compounds detected in the groundwater within the Area B Industrial/Storage Area are noted in the adjacent box. 2,4-DNT (0.0816 to 49,000 µg/L) was the most widely detected explosives compound in Area B groundwater, with concentrations occurring at Study Areas 17 and 18 and extending downgradient toward Study Area 6 (**Figure 4-13**). The following explosives compounds also were detected in the groundwater within Area B: 2,6-DNT (0.0756 to 1,700 µg/L), 2-A-4,6-DNT (0.168 to 230 µg/L), 4-amino-2,6-DNT (4-A-2,6-DNT) (1.4 to 220 µg/L), TNT (0.712 to 26,000 µg/L), nitrobenzene (1.01 to 32.3 µg/L), 1,3-dinitrobenzene (1,3-DNB) (1.04 to 81 µg/L), 1,3,5-trinitrobenzene (1,3,5-TNB) (0.461 to 93 µg/L), cyclotetramethylenetetranitramine (HMX) (2.33 to 10.1 µg/L), cyclotrimethylenetrinitramine (RDX) (2.94 to 24.1 µg/L), tetryl (13.8 µg/L), m-nitrotoluene (4.18 µg/L), o-nitrotoluene (0.494 to 60 µg/L), and p-nitrotoluene (3.15 to 23.7 µg/L). The maximum concentrations of explosives compounds were detected in wells P-10, P-11, P-17, P-44, D-9, GW-04-001, GW-04-02BR, and GW-17-006. Wells P-10, P-11 P-17, and P-44 are associated with Study Areas 6, 7, 9, and 27. Well D-9 is associated with Study Areas 5 and 21, upgradient well GW-17-006 is associated with Study Area 17, and downgradient well GW-04-001 is at the western boundary of the facility. The spatial distribution of the compounds 2,6-DNT and TNT are closely related to the observed distribution of 2,4-DNT, although these compounds were detected at lower concentrations in the northern portion of Area B (**Figures 4-14** and **4-15**). The TNT breakdown products, 2-A-4,6-DNT and 4-A-2,6-DNT, were distributed within the TNT detection area with elevated concentrations detected in the southern portion of Study Areas 17 and 18, and the highest concentrations (220 to 230 µg/L) detected in well P-10 at Study Area 6.

Maximum Concentrations	
Analyte	µg/L
Acetone	44
Carbon disulfide	0.85
Carbon tetrachloride	6.4
Chloroform	5.1
Ethylbenzene	20
Methylene chloride	2.5
MEK	130
Toluene	6.4
1,1,1-TCA	2.6
TCE	1.3
Vinyl chloride	3.5
Xylene	4.5

Volatile Organic Compounds—VOCs typically were detected in fewer than 10 percent (and in many cases fewer than 5 percent) of the environmental samples analyzed from Area B (see Table 4-6). The maximum concentrations of VOCs detected in the groundwater within the Area B Industrial/Storage Area are shown in the adjacent box. The detected VOCs included acetone (15 to 44 µg/L), carbon disulfide (0.85 µg/L), carbon tetrachloride (0.81 to 6.4 µg/L), chloroform (0.52 to 5.1 µg/L), ethylbenzene (20 µg/L), methylene chloride (2.4 to 2.5 µg/L) MEK (130 µg/L),



LEGEND:

- BUILDINGS
- PRIMARY ROADS
- SECONDARY ROADS
- TRAILS
- FENCE
- AREA BOUNDARIES
- RAIL ROAD
- CREEK, TRIBUTARIES AND RIVER
- WETLANDS
- PONDS, IMPOUNDMENTS
- GW-16-007 MONITORING WELL
- CONCENTRATION CONTOUR (10 $\mu g/L$) INTERVAL
- AREAS EXCEEDING EPA REGION III RBC VALUE OF 73 $\mu g/L$ FOR 2,4-DNT
- GRID BASED ON ALABAMA STATE PLANE EAST

NOTES:

1. BASE MAP OF AREA B RECEIVED FROM AIR SURVEY CORP. MAP COMPILED FROM AERIAL SURVEY FEBRUARY 1995.
2. OUTSIDE AREAS OF BASE MAP RECEIVED FROM AMERICAN DIGITAL CARTOGRAPHY, SCANNED FROM USGS CHILDERSBURG 7.5 QUADRANGLE, 1984, 1" = 100,000'.

STATE PLANE GRID

0 800 1600 3200

SCALE: 1" = 1600'

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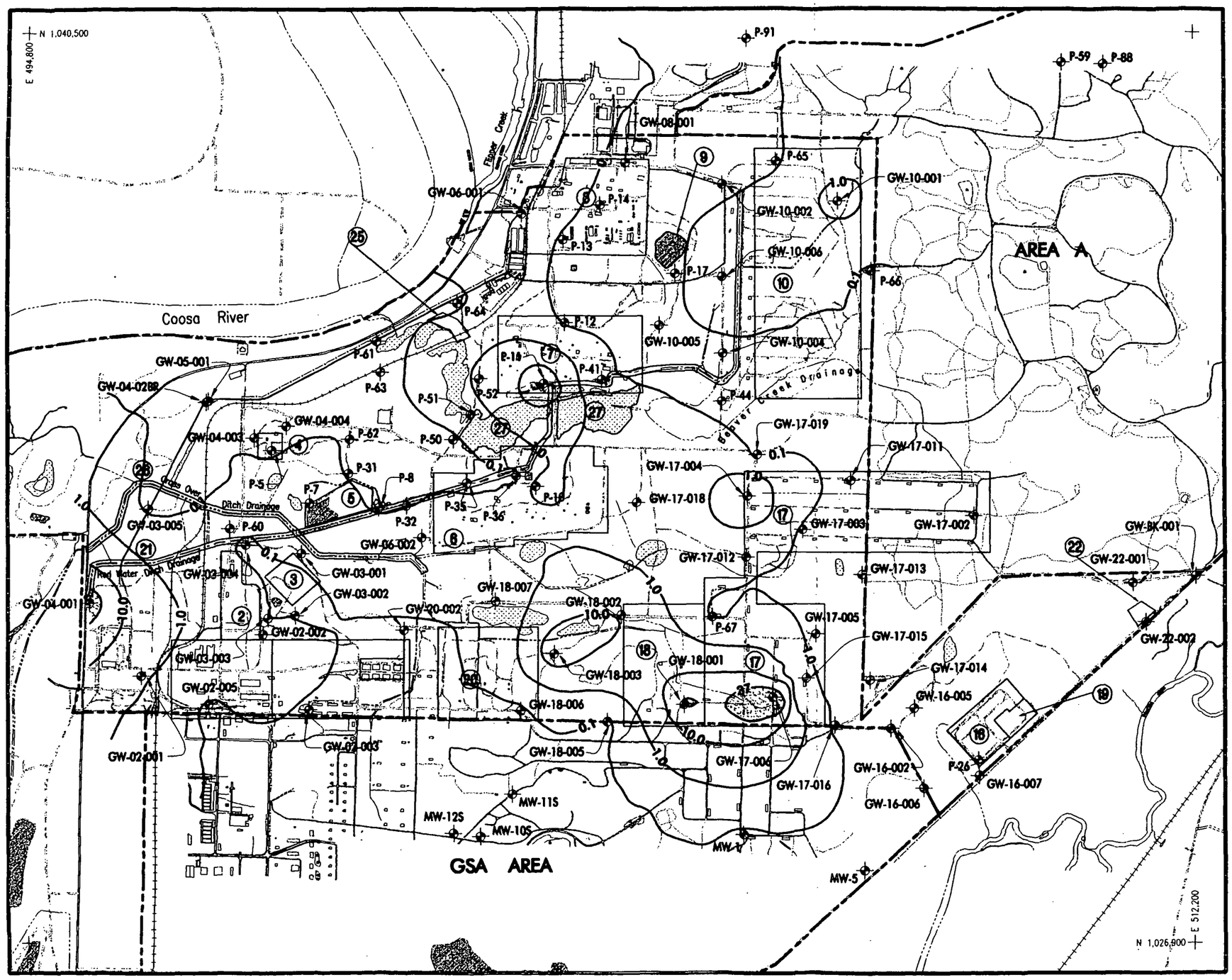
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

2,4-DNT Concentrations in Groundwater

Figure No.	Project No.	File Name	Date
4-13	01-0331-03-8178-045	00010\DWGS\E42DNT4-C	08-07-01



LEGEND:

- BUILDINGS
- PRIMARY ROADS
- SECONDARY ROADS
- TRAILS
- FENCE
- AREA BOUNDARIES
- RAIL ROAD
- CREEK, TRIBUTARIES AND RIVER
- WETLANDS
- PONDS, IMPOUNDMENTS
- GW-16-007 MONITORING WELL
- CONCENTRATION CONTOUR (10 $\mu g/L$) INTERVAL
- AREAS EXCEEDING EPA REGION III RBC VALUE OF 37 $\mu g/L$ FOR 2,6 DNT
- GRID BASED ON ALABAMA STATE PLANE EAST

NOTES:

1. BASE MAP OF AREA B RECEIVED FROM AIR SURVEY CORP. MAP COMPILED FROM AERIAL SURVEY FEBRUARY 1995.
2. OUTSIDE AREAS OF BASE MAP RECEIVED FROM AMERICAN DIGITAL CARTOGRAPHY, FROM USGS CHILDERSBURG 7.5 QUADRANGLE, 1984, 1" = 100,000'.

STATE PLANE GRID

0 800 1600 3200

SCALE: 1" = 1600'

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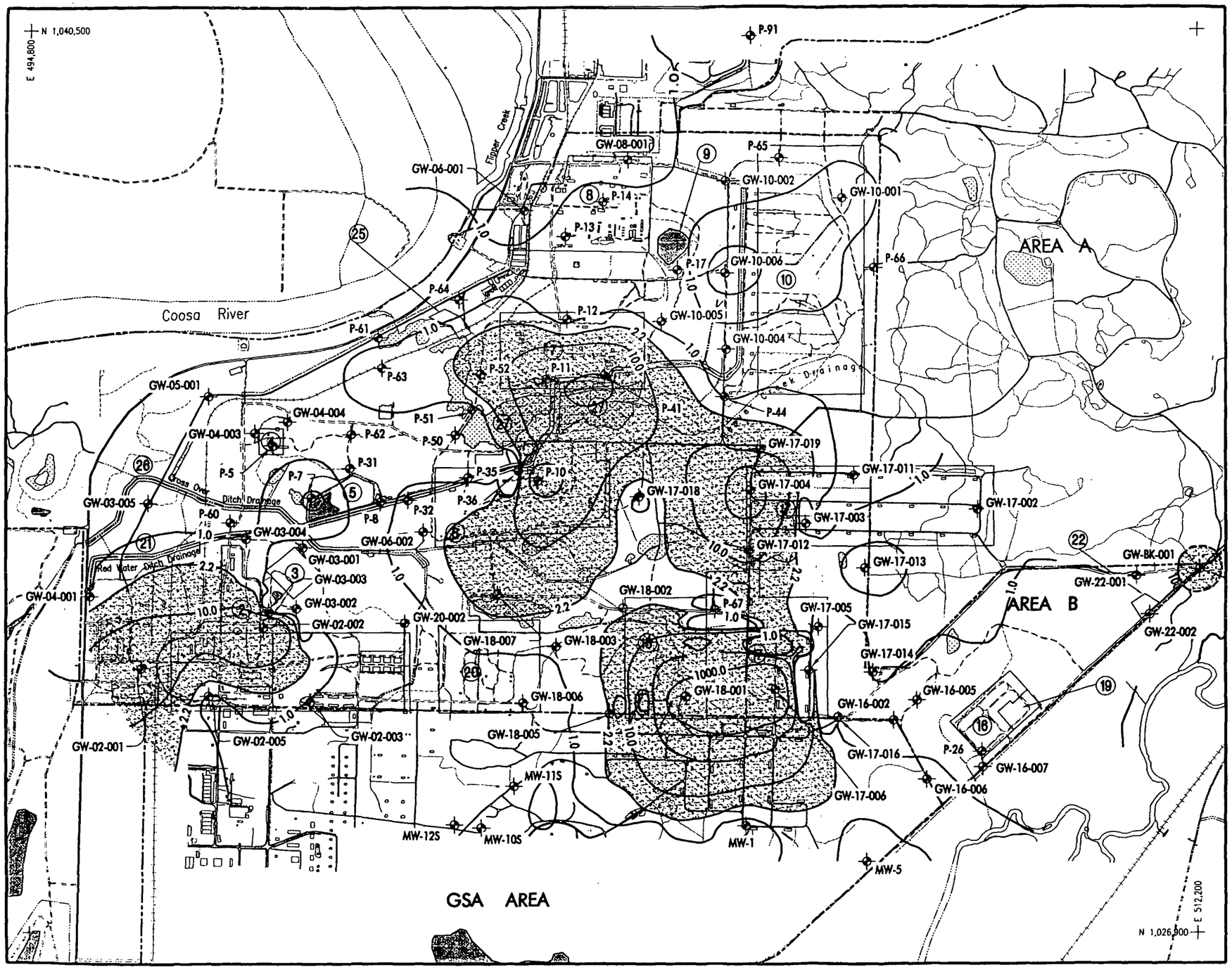
CHILDERSBURG, ALABAMA

2,6-DNT Concentrations in Groundwater

Figure No.	Project No.	File Name	Date
4-14	01-0827-03-8178-045	99015\DWGS\E42DNT6-C	03-31-99



LEGEND:

- BUILDINGS
- PRIMARY ROADS
- SECONDARY ROADS
- TRAILS
- FENCE
- AREA BOUNDARIES
- RAIL ROAD
- CREEK, TRIBUTARIES AND RIVER
- WETLANDS
- PONDS, IMPOUNDMENTS
- GW-16-007 MONITORING WELL
- CONCENTRATION CONTOUR (10 $\mu g/L$) INTERVAL
- AREAS EXCEEDING EPA REGION III RBC VALUE OF 2.2 $\mu g/L$ FOR 2,4,6-TNT
- GRID BASED ON ALABAMA STATE PLANE EAST

NOTES:

1. BASE MAP OF AREA B RECEIVED FROM AIR SURVEY CORP. MAP COMPILED FROM AERIAL SURVEY FEBRUARY 1995.
2. OUTSIDE AREAS OF BASE MAP RECEIVED FROM AMERICAN DIGITAL CARTOGRAPHY, SCANNED FROM USGS CHILDERSBURG 7.5 QUADRANGLE, 1984, 1" = 100,000'.

STATE PLANE GRID

0 800 1600 3200

SCALE: 1" = 1600'

U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

TNT Concentrations in Groundwater

Figure No.	Project No.	File Name	Date
4-15	01-0827-03-8178-045	00010\DWGS\E42TNT-C	08-07-01

toluene (0.5 to 6.4 µg/L), 1,1,1-trichloroethane (TCA) (1.8 to 2.6 µg/L), TCE (0.75 to 1.3 µg/L), vinyl chloride (3.5 µg/L), and xylene (4.5 µg/L). Toluene, acetone, and chloroform also were detected in QA/QC blank samples and are not indicative of mission-related environmental contamination in groundwater in Area B. The maximum concentrations of VOCs in Area B groundwater were detected in bedrock wells D-7B, D-9, and D-15 and soil wells P-13, P-52, P-60, P-61, and GW-06-001. The wells are located predominantly in the western portion of Area B downgradient from Study Areas 3, 5, 6, 7, 8, and 27, with the exception of well D-15, which is located downgradient of Study Area 17.

Semivolatile Organic Compounds—Phenolic, phthalate, and PAH SVOCs were detected in the Area B groundwater, and are noted in the adjacent box. PAHs were detected in 1 to 20 percent of the analyzed samples based on a minimum of 64 samples. The detected compounds consisted of acenaphthylene (1.4 to 45 µg/L), anthracene (0.12 to 0.75 µg/L), benzo(a)anthracene (0.0016 to 0.017 µg/L), benzo(a)-pyrene (0.0014 to 0.04 µg/L), benzo(b)fluoranthene (0.0018 to 0.15 µg/L), benzo(g,h,i)perylene (0.004 to 0.028 µg/L), benzo(k)fluoranthene (0.00054 to 0.035 µg/L), benzyl alcohol (2.7 µg/L), B2EHP (5.6 to 51 µg/L), chrysene (0.13 to 0.49 µg/L), dibenzo(a,h)-anthracene (0.0039 to 0.0064 µg/L), fluoranthene (0.0034 to 0.054 µg/L), indeno(1,2,3-cd)pyrene (0.0029 to 0.036 µg/L), 2-methylnaphthalene (15 to 53 µg/L), naphthalene (1.5 to 41 µg/L), N-Nitrosodiphenylamine (15 µg/L), PCP (1.35 to 10.7 µg/L), phenanthrene (0.27 to 1.1 µg/L), phenol (18 to 52 µg/L), and pyrene (0.045 to 1.6 µg/L). The maximum SVOC concentrations were detected predominantly in well P-10 (Study Area 6) and in wells P-17, P-44, D-4, D-7B, D-11, and GW-08-02BR located in the vicinity of Study Areas 7, 8, 9, and 27.

Maximum Concentrations	
Analyte	**µg/L**
Acenaphthylene	45
Anthracene	0.75
Benzo(a)anthracene	0.017
Benzo(a)pyrene	0.04
Benzo(b)fluoranthene	0.15
Benzo(g,h,i)perylene	0.028
Benzo(k)fluoranthene	0.035
Benzyl alcohol	2.7
B2EHP	51
Chrysene	0.49
Dibenzo(a,h)anthracene	0.0064
Fluoranthene	0.054
Indeno(1,2,3-cd)pyrene	0.036
2-Methylnapthalene	53
Naphthalene	41
N-Nitrosodiphenylamine	15
PCP	10.7
Phenanthrene	1.1
Phenol	52
Pyrene	1.6

Summary—The areal distribution of explosives compounds and lead in groundwater underlying the Industrial/Storage Area of Area B suggests that multiple chemical sources may be affecting groundwater quality at the installation. A predominant source area may be located in the vicinity of the former blending, shipping, and storage areas located in the southern portion of ALAAP in the vicinity of Study Areas 17 and 18. Inorganic constituent concentrations that exceed background, and organic chemical constituents that are used to characterize the nature and extent of impacted groundwater underlying Area B include the following:

- Lead (1.02 to 65,000 µg/L)
- 2,4-DNT (0.08 to 49,000 µg/L)

- TNT (0.71 to 26,000 µg/L)
- 2,6-DNT (0.08 to 1,700 µg/L)
- 2-A-4,6-DNT (0.17 to 230 µg/L)
- 4-A-2,6-DNT (1.4 to 220 µg/L).

4.4.2.2 Study Areas 16, 19, and 22 Groundwater Quality

Groundwater quality underlying Study Areas 16, 19, and 22 east of the inferred groundwater divide is affected by concentrations of organic and inorganic chemical constituents. Data summary tables for groundwater data are presented in Appendix K. **Table 4-7** summarizes the compounds and elements detected in groundwater samples analyzed between January and May 1995. The results for select chemicals (TNT, 2,4-DNT, 2,6-DNT, and lead) detected during the Phase 1, 2, and 3 groundwater sampling events are shown on Sheets 4-1 through 4-4.

Metals—Inorganic concentrations of aluminum (143 to 5,340 µg/L), barium (5.69 to 49.8 µg/L), cobalt (42 µg/L), copper (8.25 to 22.6 µg/L), iron (46.6 to 10,300 µg/L), lead (1.02 to 240 µg/L), manganese (3.85 to 1,030 µg/L), nickel (9.57 to 11.8 µg/L), potassium (469 to 24,700 µg/L), sodium (1,010 to 8,470 µg/L), vanadium (4.8 to 12.5 µg/L), and zinc (24.1 to 80.5 µg/L) were detected at concentrations exceeding background. The maximum concentrations of metals detected above background are shown in the adjacent box. Lead concentrations in bedrock groundwater ranged from 1.41 to 24.7 µg/L. Lead concentrations that exceeded background were detected in wells D-17, D-18, D-19, P-26, P-68, P-69, GW-16-005, GW-16-006, and GW-16-007. The maximum lead concentration in groundwater was detected in well GW-16-006 (240 µg/L).

Maximum Concentrations*	
Analyte	µg/L
Aluminum	5,340
Barium	49.8
Cobalt	**42**
Copper	22.6
Iron	10,300
Lead	**240**
Manganese	1,030
Nickel	**11.8**
Potassium	24,700
Sodium	8,470
Vanadium	12.5
Zinc	80.5

* Metals also determined to exceed background based on ANOVA evaluation are shown in bold

Explosives—The most widely detected explosive compounds detected in Study Areas 16, 19, and 22 are 2,4-DNT (0.0826 to 470 µg/L), 2,6-DNT (0.13 to 9.34 µg/L), and TNT (0.933 to 650 µg/L). The maximum concentrations are shown in the adjacent box. Isolated concentrations of explosives-related compounds, including 1,3,5-TNB (1.71 µg/L), 2-A-4,6-DNT (0.28 to 3.6 µg/L), 4-A-2,6-DNT (6.41 µg/L), and RDX (1.53 µg/L), were sparsely

Maximum Concentrations	
Analyte	µg/L
2,4-DNT	470
2,6-DNT	9.34
2-A-4,6-DNT	3.6
4-A-2,6-DNT	6.41
1,3,5-TNB	1.71
TNT	650
RDX	1.53

Table 4-7. Summary Statistics and Exposure Point Concentrations for Groundwater at Study Areas 16/19 - Study Areas 16/19
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:58:46 PM
Run Date: 3/29/99
Exposure Unit: GWA1WD1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/L	18 / 23	14 / 16	88%	141	141	143	5,340	1,397	1,352	Normal	1,989	1,989		1,487	[CEB][ANOVA]
Arsenic	µg/L	10 / 23	10 / 16	63%	1.00	1.00	1.1	2.2	1.1	0.56	Normal	1.3	1.3		2.4	[bk]
Barium	µg/L	23 / 23	16 / 16	100%	--	--	5.7	50	15	10	Lognormal	18	18		36	[CEB][ANOVA]
Calcium	µg/L	21 / 23	14 / 16	88%	1000	1000	1,040	26,900	6,808	7,852	Lognormal	21,413	21,413		46,406	[bk]
Chromium	µg/L	3 / 23	3 / 16	19%	6.0	7.0	7.4	8.8	4.0	1.8	Lognormal	4.6	4.6		11	[bk]
Cobalt	µg/L	1 / 23	1 / 16	6%	25	50	42	42	20	8.5	Lognormal	24	24		--	[CEB]
Copper	µg/L	3 / 23	2 / 16	13%	5.0	8.1	8.3	23	4.2	2.6	Lognormal	5.3	5.3		9.0	[CEB][ANOVA]
Iron	µg/L	22 / 23	16 / 16	100%	--	--	47	10,300	1,976	1,986	Lognormal	13,550	10,300	#	3,409	[CEB][ANOVA]
Lead	µg/L	27 / 35	15 / 16	94%	1.00	1.3	1.0	240	10	20	Lognormal	29	29		3.7	[CEB]
Magnesium	µg/L	9 / 23	7 / 16	44%	500	1000	784	17,000	3,987	5,777	Lognormal	19,532	17,000	#	20,413	[bk]
Manganese	µg/L	22 / 23	15 / 16	94%	2.8	2.8	3.9	1,030	158	252	Lognormal	2,199	1,030	#	112	[CEB][ANOVA]
Nickel	µg/L	3 / 23	3 / 16	19%	7.1	34	9.6	12	13	5.6	Lognormal	19	12	#	--	[CEB]
Potassium	µg/L	14 / 23	11 / 16	69%	375	2,080	469	24,700	3,115	6,086	Lognormal	7,323	7,323		10,226	[CEB][ANOVA]
Selenium	µg/L	1 / 23	1 / 16	6%	1.00	2.0	1.0	1.0	0.72	0.24	Lognormal	0.85	0.85		2.4	[bk]
Sodium	µg/L	16 / 23	10 / 16	63%	2,290	2,290	1,010	8,470	1,902	1,811	Lognormal	2,396	2,396		6,651	[CEB][ANOVA]
Vanadium	µg/L	6 / 23	6 / 16	38%	4.7	11	4.8	13	5.8	1.8	Lognormal	6.9	6.9		12	[CEB][ANOVA]
Zinc	µg/L	10 / 23	9 / 16	56%	21	36	24	81	28	19	Lognormal	36	36		61	[CEB][ANOVA]
1,1,1-Trichloroethane	µg/L	1 / 15	1 / 10	10%	0.50	0.50	2.4	2.4	0.32	0.23	Lognormal	0.42	0.42		--	[CEB]
1,3,5-Trinitrobenzene	µg/L	1 / 35	1 / 16	6%	0.45	0.45	1.7	1.7	0.26	0.12	Lognormal	0.29	0.29		--	[CEB]
2,4,6-Trinitrotoluene	µg/L	9 / 35	6 / 16	38%	0.64	0.64	0.93	650	29	111	Lognormal	36	36		--	[CEB]
2,4-Dinitrotoluene	µg/L	20 / 35	11 / 16	69%	0.064	0.27	0.083	470	27	81	Lognormal	16,070	470	#	--	[CEB]
2,6-Dinitrotoluene	µg/L	10 / 35	6 / 16	38%	0.074	0.074	0.13	9.3	0.31	0.88	Lognormal	0.51	0.51		--	[CEB]
2-Amino-4,6-Dinitrotoluene	µg/L	4 / 35	2 / 16	13%	0.16	0.16	0.28	3.6	0.20	0.45	Lognormal	0.23	0.23		--	[CEB]
4-Amino-2,6-Dinitrotoluene	µg/L	1 / 35	1 / 16	6%	1.6	1.6	6.4	6.4	0.90	0.47	Lognormal	1.0	1.0		--	[CEB]
Acetone	µg/L	1 / 15	1 / 10	10%	13	18	22	22	7.7	2.5	Lognormal	9.0	9.0		--	[CEB]
Benzo(a)pyrene	µg/L	1 / 18	1 / 12	8%	0.0013	4.7	0.0017	0.0017	0.59	0.94	Lognormal	479,943	0.0017	#	--	[CEB]
Benzo(b)fluoranthene	µg/L	1 / 18	1 / 12	8%	0.0016	5.4	0.0024	0.0024	0.68	1.1	Lognormal	408,279	0.0024	#	--	[CEB]
Benzo(g,h,i)perylene	µg/L	2 / 18	2 / 12	17%	0.0040	6.1	0.0067	0.017	0.76	1.2	Lognormal	20,247	0.017	#	--	[CEB]
Benzo(k)fluoranthene	µg/L	2 / 18	2 / 12	17%	0.00044	0.87	0.00048	0.0020	0.11	0.17	Lognormal	6,792	0.0020	#	--	[CEB]
Benzyl Alcohol	µg/L	3 / 18	3 / 12	25%	0.72	0.72	0.89	1.9	0.56	0.46	Lognormal	0.77	0.77		--	[CEB]
Fluoranthene	µg/L	2 / 18	2 / 12	17%	0.0034	3.3	0.0040	0.0067	0.41	0.66	Lognormal	3,168	0.0067	#	--	[CEB]
Indeno(1,2,3-cd)pyrene	µg/L	2 / 18	2 / 12	17%	0.0025	8.6	0.0094	0.0095	1.1	1.7	Lognormal	81,131	0.0095	#	--	[CEB]
Naphthalene	µg/L	1 / 18	1 / 12	8%	0.50	0.90	1.3	1.3	0.44	0.16	Lognormal	0.53	0.53		--	[CEB]
Pentachlorophenol	µg/L	1 / 18	1 / 12	8%	1.2	18	2.4	2.4	3.6	3.3	Lognormal	14	2.4	#	--	[CEB]
Phenol	µg/L	6 / 18	5 / 12	42%	9.2	9.2	18	180	29	42	Lognormal	120	120		--	[CEB]
RDX	µg/L	1 / 35	1 / 16	6%	1.2	1.2	1.5	1.5	0.60	0.079	Lognormal	0.63	0.63		--	[CEB]
Toluene	µg/L	2 / 15	2 / 10	20%	0.50	2.2	0.62	3.3	0.49	0.48	Lognormal	0.80	0.80		--	[CEB]
Xylene	µg/L	1 / 15	1 / 10	10%	0.84	0.84	1.3	1.3	0.46	0.14	Lognormal	0.53	0.53		--	[CEB]
bis(2-Ethylhexyl)phthalate	µg/L	2 / 18	2 / 12	17%	4.8	35	70	88	12	15	Lognormal	27	27		--	[CEB]
di-N-Butyl Phthalate	µg/L	1 / 18	1 / 12	8%	3.7	3.7	5.4	5.4	2.0	0.51	Lognormal	2.2	2.2		--	[CEB]

Table 4-7. Summary Statistics and Exposure Point Concentrations for Groundwater at Study Areas 16/19 - Study Areas 16/19 (Continued)
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:58:46 PM
Run Date: 3/29/99
Exposure Unit: GWAIWDI

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]	2 x BK Mean[d]	Background Comparison[g]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

detected with the maximum concentrations occurring in well GW-BK-001. The explosives compounds were detected primarily in the southwestern corner of Study Area 16 (wells D-16, P-26, and P-68) and west of Study Area 16 (GW-16-002, GW-16-005, GW-16-006, GW-16-007, and P-69) surrounding a pronounced sinkhole. The highest explosives concentrations were detected sporadically in isolated wells located east of Study Areas 16 and 19 (well P-70) and around Study Area 22 (wells GW-22-001 and GW-BK-001).

Volatile Organic Compounds—VOCs were sparsely detected in the groundwater underlying Study Areas 16, 19, and 22. The maximum concentrations of VOCs detected in the groundwater east of the inferred groundwater divide are shown in the adjacent box. Isolated concentrations of acetone (22 µg/L), toluene (0.62 to 3.3 µg/L), 1,1,1-TCA (2.4 µg/L), and xylene (1.3 µg/L) were detected in wells D-16, P-68, and P-70.

Maximum Concentrations	
Analyte	µg/L
Acetone	22
Toluene	3.3
1,1,1-TCA	2.4
Xylene	1.3

Semivolatile Organic Compounds—Benzyl alcohol (0.89 to 1.9 µg/L); B2EHP (70 to 88 µg/L); di-N-butyl phthalate (5.4 µg/L); PCP (2.36 µg/L); phenol (18 to 180 µg/L); and the PAHs benzo(a)pyrene (0.0017 µg/L), benzo(b)fluoranthene (0.0024 µg/L), benzo(g,h,i)perylene (0.0067 to 0.017 µg/L), benzo(k)-fluoranthene (0.00048 to 0.002 µg/L), fluoranthene (0.004 to 0.0067 µg/L), indeno(1,2,3-cd)pyrene (0.0094 to 0.0095 µg/L), and naphthalene (1.3 µg/L) were detected in the groundwater. The maximum SVOC concentrations shown in the adjacent box were variably detected in wells D-16, D-19, P-26, P-68, P-70, and GW-BK-001.

Maximum Concentrations	
Analyte	µg/L
Benzo(a)pyrene	0.0017
Benzo(b)fluoranthene	0.0024
Benzo(g,h,i)perylene	0.017
Benzo(k)fluoranthene	0.002
Benzyl alcohol	1.9
B2EHP	88
Di-N-butyl phthalate	5.4
Fluoranthene	0.0067
Indeno(1,2,3-cd)pyrene	0.0095
Naphthalene	1.3
PCP	2.36
Phenol	180

Summary—The distribution of explosives compounds and metals in groundwater underlying Study Areas 16, 19, and 22 suggest that multiple chemical sources may be affecting groundwater quality in the vicinity of the sites. VOCs, SVOCs, and metals were associated predominantly with Study Areas 16 and 19. Inorganic constituent concentrations that exceed background and organic chemical constituents that are used to characterize the nature and extent of impacted groundwater underlying Study Areas 16, 19, and 22 include the following:

- TNT (0.933 to 650 µg/L)
- 2,4-DNT (0.0826 to 470 µg/L)
- Lead (1.02 to 240 µg/L).

4.4.2.3 Kimberly-Clark Monitoring Wells

Groundwater samples were obtained from existing monitoring wells on the Alliance (formerly Kimberly-Clark) property located south of Study Areas 17 and 18. The property formerly was part of the ALAAP facility. Wells MW-10S, MW-11S, MW-12S, PMW-1, PMW-3, PMW-5, PMW-7, and PMW-8 were sampled for explosives compounds and lead. Appendix K presents data summary tables for the groundwater. **Table 4-8** provides summary statistics for explosives compounds and lead detected in the groundwater.

Metals—Lead was detected in five of the wells, ranging in concentration from 2.5 to 123 µg/L.

Explosives—Isolated concentrations of 2,4-DNT (0.286 to 18 µg/L) and TNT (3.41 µg/L) were detected in wells PMW-1, PMW-5, and MW-11S. The maximum concentrations detected are shown in the adjacent box.

Maximum Concentrations	
Analyte	µg/L
2,4-DNT	18
TNT	3.41

4.5 SOIL RESULTS

This section provides the results of analysis of field screening and laboratory confirmatory soil samples collected during the Supplemental RI at ALAAP (Section 4.5.1). Confirmatory samples are compared to background using the methodology presented in Section 4.3. Background soil results are presented in Section 4.5.2. The remainder of this section is divided into subsections for each study area. For each study area, CEBs are listed, along with the maximum concentration detected in the study area for each soil interval. Where appropriate, the data are discussed with respect to horizontal and vertical extent of contamination.

Tables of summary statistics for detected chemicals are provided for three depth intervals: 0 to 1 foot BLS (referred to as surface), 1 to 10 feet BLS (referred to as shallow subsurface), and greater than 10 feet BLS (referred to as deep subsurface). Figures are provided for each study area and depth interval that depict the presence of CEBs for groups of analytes: metals, explosives, VOCs, and SVOCs at each sampling point. Pesticides and PCBs also are shown in figures for those study areas in which they were target analytes. For metals, "presence" denotes presence of metals at concentrations that equaled or exceeded two times the average background concentrations. For organic compounds, the figure indicates analytical detection. At each sampling point, a circle is divided into quadrants—one for each group of analytes. A blank quadrant indicates that no CEBs were present for that analysis group. At locations where samples were not collected in a particular soil horizon, the circles are left blank and no quadrants are displayed. Complete data summary tables for each media, study area, and depth interval are presented in Appendix K. For each study area, a box is featured in the text that lists the maximum concentration

Table 4-8. Summary Statistics and Exposure Point Concentrations for Groundwater at Study Area KC - Kimberly Clark
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 7:21:21 PM
Run Date: 3/29/99
Exposure Unit: KC_WD1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Lead	µg/L	9 / 10	7 / 8	88%	1.3	1.3	2.5	123	21	41	Lognormal	396	123	#	3.7	[CEB][ANOVA]
2,4,6-Trinitrotoluene	µg/L	1 / 10	1 / 8	13%	0.64	0.64	3.4	3.4	0.51	0.55	Lognormal	0.89	0.89		- -	[CEB]
2,4-Dinitrotoluene	µg/L	3 / 10	3 / 8	38%	0.064	0.064	0.29	18	1.2	3.1	Lognormal	134	18	#	- -	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
- - Not applicable (note: background comparison not conducted for organic compounds)

of the CEBs for each depth interval. An analyte may be present at a particular interval, but may not be a CEB for that interval. In this instance, the maximum value is not shown.

4.5.1 Results of Field Screening

Field screening of environmental media was conducted during Phases 1 and 2 of the Supplemental RI to provide real-time information on contaminant concentrations in various media. During Phase 1, surface soil samples were screened for explosives and lead, and subsurface soil samples were screened for explosives. The screening was conducted to evaluate the nature and extent of contamination. During Phase 2, subsurface soil, borehole water, groundwater from wells, surface water, and sediment were screened for explosives. The screening was conducted to provide information to aid in monitoring well and additional soil boring placement. The screening methods used during each phase and for each media are described in Section 3.4. In the following sections, the results of field screening are discussed. All field screening results are tabulated in Appendix C, along with a data quality assessment of the Phase 1 field screening.

4.5.1.1 Results of Phase 1 Explosives Screening

Surface Soils—A total of 278 surface soil samples from 10 study areas, including Community Environmental Response Facilitation Act (CERFA) sites and background locations, were field-tested during Phase 1. The testing was conducted to estimate the concentrations of explosives-related contamination in the surface soil on ALAAP. **Table 4-9** summarizes the range of explosives concentrations detected at each study area. The lateral extent of explosives contamination in surface soil at Study Areas 6 and 7 was delineated by Roy F. Weston, using systematic site gridding and field screening.

The horizontal extent of surface soil (0 to 0.5 feet) contamination was estimated by evaluating the spatial distribution of the screening concentrations in samples collected on the systematically aligned grid squares. **Sheet 4-5** shows the distribution of surface soil screening results for explosives and lead. Calculated concentrations of TNT equivalents ranged from <2.5 (detection limit) to 3,960 μg/g. The distribution of screening-level TNT concentrations exceeding the Phase 1 target concentration of 580 μg/g indicates that TNT contamination occurs on ALAAP in discrete areas and is not widely distributed. These conclusions were in agreement with the screening results from prior investigations conducted by Roy F. Weston. TNT concentrations in surface soil exceeding the industrial usage screening concentration of 540 μg/g were detected at Study Areas 16 and 17 (see Sheet 4-5). Additional screening samples were collected at Study Area 17 to delineate further the extent of explosives contamination. TNT concentrations exceeding the Phase 1 residential-usage screening concentration of 30 μg/g were detected at Study Areas 2, 16, 17, and 18 (see Sheet 4-5).

Table 4-9. Summary of Soil Screening Data - TNT - Surface Soil
Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area	Number of Samples	Minimum	Maximum	Units	Number of Detects
02 Smokeless Powder Facility	41	<2.50	200.00	µg/g	18
03 Sanitary Landfill and Lead Facility	8	<2.50	<2.50	µg/g	0
08 Acid/Organic Manufacturing Area	44	<2.50	25.00	µg/g	8
10 Tetryl Manufacturing Area	48	<2.50	4.00	µg/g	2
16 Flashing Ground	63	<2.50	816.00	µg/g	28
17 Propellant Shipping Area	47	<2.50	3960.00	µg/g	21
18 Blending Tower Area	8	<2.50	32.40	µg/g	3
19 Lead Facility	2	<2.50	<2.50	µg/g	0
20 Rifle Powder Finishing Area	7	<2.50	<2.50	µg/g	0
B6 Coke Oven	10	<2.50	3.30	µg/g	1

The presence of other nitroaromatic compounds, other than TNT, was indicated by color changes observed during the screening analyses. The predominant colorimetric reaction observed from the surface soil analyses was light to dark yellow, indicative of the presence of naturally occurring humic acids in the soil samples. Concentrations of TNT or 2,6-DNT were indicated by a pink color reaction. Trace concentrations of tetryl (light orange) are indicated in isolated surface soil samples at Study Areas 2, 16, and 17, in addition to indicator concentrations of 1,3-DNB (purple) at Study Area 16, and 2,4-DNT (blue) at Study Areas 2 and 17. Although the presence of additional explosives-related compounds is indicated colorimetrically, total concentrations were quantified as TNT. Confirmation of contaminant concentrations was obtained from fixed laboratory analyses performed on approximately 10 percent of the field screened samples.

Subsurface Soil (Soil Borings)—The vertical extent of soil contamination by explosives and lead was estimated by analyzing samples collected from 64 vertical soil borings collected from delineated areas of surface soil contamination. A total of 333 subsurface soil samples were screened for the presence of explosives-related compounds from 16 study areas and background locations. **Table 4-10** summarizes the Phase 1 screening results for the borings in each study area. The results of the subsurface soil screening results are shown on **Sheet 4-6**.

The distribution of screening-level explosives concentrations indicates that subsurface explosives contamination occurs in discrete, randomly distributed areas and is not widely distributed. This pattern of dispersal of explosives constituents in subsurface soils was confirmed by extensive screening data and soil excavation at Study Areas 6 and 7 (Weston 1995). The estimated concentrations of nitroaromatic compounds (such as TNT) in subsurface soils on ALAAP ranged from <2.5 to 73 µg/g. TNT was not detected in subsurface soils exceeding the Phase 1 industrial usage screening concentration of 580 µg/g. Concentrations of TNT exceeding the Phase 1 residential-usage screening level of 30 µg/g were detected at Study Area 16.

The presence of other nitroaromatic compounds was indicated by color changes observed during the screening analyses of subsurface soil samples. As observed in the surface soil samples, the predominant color reaction observed was yellow, indicating the presence of naturally occurring humic acids in the soil samples. Blue colorimetric reactions were observed in isolated samples from Study Areas 17 and 18, indicating the presence of trace concentrations (<2.5 to 18 µg/g) of 2,4-DNT (as TNT) in these areas. Samples from Study Areas 7 (SB-07-016) and 10 (SB-10-028) indicated colorimetric tetryl reactions at concentrations ranging from <2.5 to 5.9 µg/g. 1,3,5-TNB (red) interference (25 to 73 µg/g) was detected in two samples from a single boring (SB-16-061) drilled at Study Area 16. Light green to green color changes are attributed to the filtering process used in the field laboratory. Confirmation of contaminant concentrations was obtained from fixed laboratory analysis performed on approximately 10 percent of the field screened samples.

Table 4-10. Summary of Soil Screening Data - TNT - Soil Boring
Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area	Number of Samples	Minimum	Maximum	Units	Number of Detects
02 Smokeless Powder Facility	24	<2.50	7.60	µg/g	8
03 Sanitary Landfill and Lead Facility	20	<2.50	5.00	µg/g	5
04 Manhattan Project Area	6	<2.50	12.50	µg/g	1
06 Southern TNT Manufacturing Area	32	<2.50	7.60	µg/g	5
07 Northern TNT Manufacturing Area	28	<2.50	5.00	µg/g	6
08 Acid/Organic Manufacturing Area	30	<2.50	5.00	µg/g	10
10 Tetryl Manufacturing Area	41	<2.50	5.90	µg/g	5
16 Flashing Ground	35	<2.50	73.00	µg/g	2
17 Propellant Shipping Area	31	<2.50	18.00	µg/g	4
18 Blending Tower Area	12	<2.50	5.00	µg/g	4
19 Lead Facility	12	<2.50	4.20	µg/g	3
20 Rifle Powder Finishing Area	12	<2.50	4.20	µg/g	6
25 Storage Battery/Demolition Debris	5	<2.50	<2.50	µg/g	0
B6 Coke Oven	15	<2.50	4.20	µg/g	4
BK Background	7	<2.50	<2.50	µg/g	0
GS Gas Station	8	<2.50	<2.50	µg/g	0
PS Pesticide Storage Building	15	<2.50	4.20	µg/g	1

4.5.1.2 Results of Phase 2 Explosives Screening

Subsurface Soils—Subsurface soil screening for explosives was conducted during Phase 2 of the Supplemental RI to optimize monitoring well location decisions. Twenty-four samples from 17 soil borings were analyzed for explosives. The results were used to place monitoring wells and additional soil borings in areas affected by explosives contamination. The contaminant levels ranged from <0.062 to 9.4 ppm for 2,4-DNT and <0.087 to 14.5 ppm for TNT. The explosives concentrations in 9 of the 24 samples were below the detection limits for both TNT and 2,4-DNT. The TNT values are all well below the Phase 1 residential-usage screening level of 30 ppm for TNT. The results of these analyses are presented in Appendix C and on Sheet 4-6.

Borehole Water—Water samples were collected from the same boreholes from which the subsurface soil samples were collected. The water and soil samples were collected for the same reason as the soil samples, which was to provide information on a real-time basis for decisions on monitoring well and soil boring placement. The soil boring and borehole water samples were evaluated concurrently when making these decisions. Thirty-eight water samples from 22 boreholes were screened for explosives. 2,4-DNT concentrations ranged from 0.0637 to 120 ppb. Of the 38 samples, 26 were below their detection limits for 2,4-DNT, and TNT was not detected in the borehole water samples. In general, 2,4-DNT concentrations were slightly higher in the water samples than in the soil samples. TNT concentrations, however, although low in the soil samples, were not detected in the water samples. The results are tabulated in Appendix C.

Groundwater—Groundwater samples were collected and screened onsite during Phase 2 of the Supplemental RI to provide information used for monitoring well and soil boring placement. Sixty-eight samples from 48 wells were screened for explosives. The range of 2,4-DNT concentrations was <10 to 9,760 µg/L, and the range of TNT concentrations was <20 to 108 µg/L. The maximum detected 2,4-DNT concentration was in GW-04-001 (9,760 µg/L) and the maximum detected TNT concentration was in GW-17-004 (108 µg/L). Only 6 of the 68 samples contained TNT above the detection limit, while 41 of the 68 samples contained 2,4-DNT above the detection limit. 2,4-DNT was detected at a higher frequency than TNT in the borehole water samples; however, the explosives concentrations in the borehole water were considerably lower. In addition, the groundwater samples contained generally higher explosives concentrations than the soil samples discussed earlier. Detailed results for the field screening of groundwater are presented in Appendix C.

Surface Water—Nine surface water samples were collected during Phase 2. These samples provided supplementary information to the screening data discussed in the preceding paragraphs. The samples were collected from five locations. For each location, one sample was filtered before analysis and one sample was not filtered. TNT was not detected in any of the samples, and only three of the samples contained 2,4-DNT above reporting limits. All three of those samples were filtered. 2,4-DNT concentrations in these samples were 40 µg/L (BW-BK-002 and SW-27-036)

and 30 µg/L (SW-SP-012). Sample location BW-BK-002 is a background location. Detailed screening results for all Phase 2 surface water samples are presented in Appendix C.

Sediment—One sediment sample was collected during Phase 2 at SD-21-500. This sample, in conjunction with the surface water explosives screening results, provided limited supplemental information for monitoring well and soil boring placement decisions. The sample was analyzed onsite for 2,4-DNT and TNT. Concentrations detected were low: 4.4 µg/g for 2,4-DNT and 7.35 µg/g for TNT. For comparison, the Phase 1 residential-usage screening level for TNT was 30 µg/g. These field screening results are tabulated in Appendix C.

4.5.1.3 Quantitative Lead Screening Results

During previous investigations at ALAAP, lead was identified as a contaminant in several areas. After considering the possibility of onsite analysis of lead samples using x-ray fluorescence (XRF) instrumentation, it was determined that a more cost-effective approach for this investigation would be the implementation of quick-turnaround lead screening analysis provided by a fixed laboratory. PACE Environmental Laboratories of Minneapolis, Minnesota, was contracted to analyze lead samples and provide results to the field manager within 24 to 48 hours. Lead analyses were completed at the fixed laboratory by ICAP emission spectroscopy. The analytical detection limit for the lead analyses was 10 µg/g.

Lead concentrations were determined for 69 surface soil samples from Study Areas 3, 4, 16, 19, 22, and 25, with concentrations ranging from <10 to 24,000 µg/g (**Table 4-11**). The concentrations of detected lead in 93 subsurface soil samples from Study Areas 3, 4, 16, 19, 22, and 25 ranged from <10 to 15,000 µg/g (**Table 4-12**).

Lead concentrations exceeding a screening criteria of 400 µg/g in surface and subsurface soils were detected at Study Areas 4, 16, 19, and 22 (Appendix C). Lead concentrations in surface soils are shown on Sheet 4-5 and lead concentrations in subsurface soils are shown on Sheet 4-6.

4.5.2 Background Soil Results

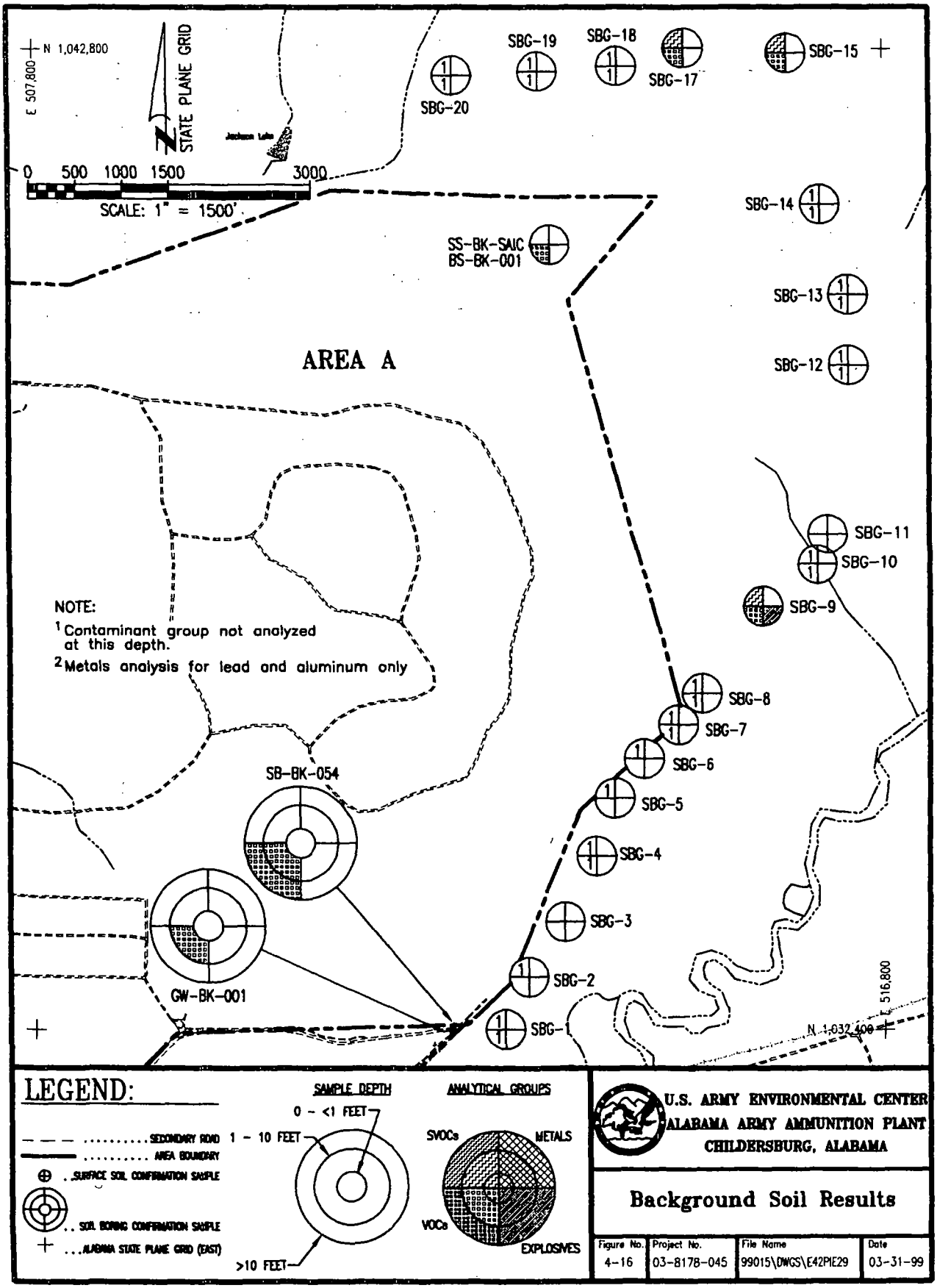
ESE collected soil samples between October 27 and November 4, 1993, from 20 sampling points outside the historical ALAAP boundary. Samples from 19 of these 20 sampling points were used in the Supplemental RI background data set. Data from location SBG-16 were not used in the background data set because the lead concentration (156 µg/g) was high compared to the other 19 sampling points. **Figure 4-16** provides the background locations for soils and identifies the groups of analytes that were present in the soils. Four samples (SBG-3, SBG-9, SBG-15, and SBG-17) were analyzed for metals, explosives, VOCs, SVOCs, and pesticides/PCBs. Heavy metals (i.e., arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc) were analyzed in soils from all 19 sampling points. Each of the 19 samples also was analyzed for explosives (1,3-DNB, 2,4-DNT, 2,6-DNT, NB, tetryl, 1,3,5-TNB, and TNT). An additional

Table 4-11. Summary of Soil Screening Data - Lead - Surface Soil
Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area	Number of Samples	Minimum	Maximum	Units	Number of Detects
03 Sanitary Landfill and Lead Facility	3	38.40	278.00	µg/g	3
04 Manhattan Project Area	4	21.40	1800.00	µg/g	4
16 Flashing Ground	38	<10.00	5400.00	µg/g	36
19 Lead Facility	15	43.10	24000.00	µg/g	15
22 Demolition Landfill	6	13.30	4600.00	µg/g	6
25 Storage Battery/Demolition Debris	3	24.80	51.80	µg/g	3

Table 4-12. Summary of Soil Screening Data - Lead - Soil Boring
Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area	Number of Samples	Minimum	Maximum	Units	Number of Detects
03 Sanitary Landfill and Lead Facility	12	<10.00	201.00	µg/g	10
04 Manhattan Project Area	16	<10.00	201.00	µg/g	11
16 Flashing Ground	32	<10.00	534.00	µg/g	20
19 Lead Facility	6	<10.00	56.30	µg/g	2
22 Demolition Landfill	15	<10.00	15000.00	µg/g	9
25 Storage Battery/Demolition Debris	12	<10.00	48.30	µg/g	9


N 1,042,800
E 507,800
STATE PLANE GRID
0 500 1000 1500 3000
SCALE: 1" = 1500'
SBG-20
SBG-19
SBG-18
SBG-17
SBG-15
SBG-14
SS-BK-SAIC
BS-BK-001
SBG-13
SBG-12
AREA A
SBG-11
SBG-10
SBG-9
NOTE:
1 Contaminant group not analyzed at this depth.
2 Metals analysis for lead and aluminum only
SBG-8
SBG-7
SBG-6
SB-BK-054
SBG-5
SBG-4
SBG-3
SBG-2
GW-BK-001
SBG-1
E 516,800
N 1,032,400
LEGEND:
SECONDARY ROAD
AREA BOUNDARY
SURFACE SOIL CONFIRMATION SAMPLE
SOIL BORING CONFIRMATION SAMPLE
ALABAMA STATE PLANE GRID (EAST)
SAMPLE DEPTH
0 - <1 FEET
1 - 10 FEET
>10 FEET
ANALYTICAL GROUPS
SVOCs
METALS
VOCs
EXPLOSIVES
U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA
Background Soil Results
Figure No. 4-16
Project No. 03-8178-045
File Name 99015\DWGS\E42PIE29
Date 03-31-99

background surface soil sample was collected near the northeastern boundary of Area A during the Supplemental RI. This sample was collected for use with the bioassay tests, but also provides information on background concentrations of analytes. Two soil borings (GW-BK-001 and SB-BK-054) were drilled and completed as monitoring wells during the Supplemental RI near the southeastern edge of the Area B boundary (see Figure 4-16). Soil samples were collected from the boreholes and represent background soil conditions. **Tables 4-13**, **4-14**, and **4-15** provide summary statistics for the background soil samples collected. Data summary tables are presented in Appendix K.

Metals—Nineteen metals were detected in the background soils. Of these 19 metals, 4 were essential nutrients. Antimony, cadmium, hexavalent chromium, molybdenum, silver, and thallium were not detected. No apparent patterns were found with respect to the distribution of the metals detected in the background soils. Concentrations of lead at all background sampling points were less than 40 µg/g.

Explosives—TNT was detected in only one (SBG-9) of the background surface soil sampling points at 6.04 µg/g. No other explosives were detected in the 20 samples. Six subsurface intervals from each of the borings were screened in the field for explosives and analyzed in the laboratory. Explosives were not detected in any sample.

VOCs—Four VOCs were detected in surface soils: acetone, benzene, chlorobenzene, and toluene. All four VOCs were detected at surface soil sample location SBG-9. Acetone was detected in three surface soil samples at concentrations ranging from 10 to 60 µg/g. Acetone is a common laboratory contaminant. Concentrations of the other VOCs detected in surface soil samples collected by ESE were 0.4 µg/g chlorobenzene, 0.60 µg/g benzene, and 0.6 µg/g toluene. Toluene was detected in the background soil sample collected from Area A at 0.02 µg/g. Acetone and toluene were detected in both the shallow and deep subsurface soil samples. Acetone in subsurface soils ranged from 0.037 to 1.4 µg/g. Toluene concentrations were low (≤0.008 µg/g) in subsurface soils.

SVOCs—Di-n-butyl phthalate was the only SVOC detected in surface soils and is a common laboratory contaminant. Di-N-butyl phthalate was detected in three samples collected by ESE at concentrations ranging from 0.11 to 0.26 µg/g. SVOCs were not detected in the background sample collected from Area A. SVOCs were not detected in the subsurface soils.

Pesticides/PCBs—Pesticides and PCBs were not detected in any background soil samples.

Summary—Nineteen metals were detected in the background soils. Four VOCs were detected at trace concentrations, with the exception of acetone, which ranged in concentration from 10 to 60 µg/g. TNT was detected in one sample at 6.04 µg/g. One SVOC was detected at concentrations ≤0.26 µg/g. Pesticides and PCBs were not detected in any background soil samples.

Table 4-13. Summary Statistics and Exposure Point Concentrations for Soil (0-<1 ft BLS) at Study Area BK - Background
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 12:18:03 PM
Run Date: 3/31/99
Exposure Unit: BK__SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	7 / 7	6 / 6	100%	--	--	5,700	16,000	10,138	3,966	Normal	13,401	13,401		20,277	[CEB]
Arsenic	µg/g	19 / 20	19 / 20	95%	13	13	3.9	12	7.6	2.1	Normal	8.4	8.4		15	[CEB]
Barium	µg/g	5 / 5	5 / 5	100%	--	--	23	117	62	35	Normal	96	96		124	[CEB]
Beryllium	µg/g	1 / 5	1 / 5	20%	0.50	0.50	1.1	1.1	0.41	0.36	Lognormal	1.2	1.1	#	0.82	[CEB]
Calcium	µg/g	5 / 5	5 / 5	100%	--	--	186	11,000	2,480	4,764	Lognormal	1.05E+06	11,000	#	4,960	[CEB]
Chromium	µg/g	20 / 20	20 / 20	100%	--	--	7.8	68	27	16	Lognormal	35	35		54	[CEB]
Cobalt	µg/g	4 / 5	4 / 5	80%	1.4	1.4	6.7	10	7.1	3.8	Normal	11	10	#	14	[CEB]
Copper	µg/g	20 / 20	20 / 20	100%	--	--	2.6	25	6.6	4.8	Lognormal	8.2	8.2		13	[CEB]
Iron	µg/g	5 / 5	5 / 5	100%	--	--	10,700	24,800	18,780	6,831	Normal	25,293	24,800	#	37,560	[CEB]
Lead	µg/g	22 / 22	21 / 21	100%	--	--	6.5	37	17	7.5	Lognormal	20	20		34	[CEB]
Magnesium	µg/g	5 / 5	5 / 5	100%	--	--	149	1,950	594	765	Lognormal	8,985	1,950	#	1,189	[CEB]
Manganese	µg/g	5 / 5	5 / 5	100%	--	--	195	1,440	865	543	Normal	1,383	1,383		1,730	[CEB]
Mercury	µg/g	1 / 20	1 / 20	5%	0.050	0.087	0.067	0.067	0.028	0.0100	Lognormal	0.031	0.031		0.056	[CEB]
Nickel	µg/g	17 / 20	17 / 20	85%	1.7	7.5	2.6	12	4.7	2.9	Lognormal	6.9	6.9		9.4	[CEB]
Potassium	µg/g	3 / 5	3 / 5	60%	100	100	217	1,160	340	466	Lognormal	23,549	1,160	#	680	[CEB]
Selenium	µg/g	11 / 20	11 / 20	55%	0.25	12	0.34	0.70	0.62	1.3	Lognormal	0.88	0.70	#	1.2	[CEB]
Sodium	µg/g	5 / 5	5 / 5	100%	--	--	88	319	251	93	Lognormal	605	319	#	501	[CEB]
Vanadium	µg/g	5 / 5	5 / 5	100%	--	--	19	55	38	15	Normal	52	52		76	[CEB]
Zinc	µg/g	13 / 20	13 / 20	65%	8.0	32	9.9	63	18	15	Lognormal	31	31		36	[CEB]
2,4,6-Trinitrotoluene	µg/g	1 / 20	1 / 20	5%	0.089	0.46	6.0	6.0	0.51	1.3	Lognormal	0.55	0.55		--	[CEB]
Acetone	µg/g	4 / 6	3 / 5	60%	0.017	0.045	10.0	60	18	25	Normal	42	42		--	[CEB]
Benzene	µg/g	1 / 6	1 / 5	20%	0.0015	0.0025	0.60	0.60	0.12	0.27	Lognormal	1.21E+08	0.60	#	--	[CEB]
Chlorobenzene	µg/g	1 / 6	1 / 5	20%	0.00086	0.0025	0.40	0.40	0.081	0.18	Lognormal	1.42E+08	0.40	#	--	[CEB]
Toluene	µg/g	2 / 6	2 / 5	40%	0.00078	0.00100	0.024	0.60	0.13	0.27	Lognormal	1.23E+11	0.60	#	--	[CEB]
Total Organic Carbon	µg/g	1 / 1	1 / 1	100%	--	--	27,700	27,700	27,700	--	Undetermined	--	27,700	#	--	[CEB]
di-N-Butyl Phthalate	µg/g	5 / 7	3 / 5	60%	0.31	0.51	0.11	0.26	0.18	0.071	Normal	0.25	0.25		--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-14. Summary Statistics and Exposure Point Concentrations for Soil (1-10 ft BLS) at Study Area BK - Background
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 12:18:04 PM
Run Date: 3/31/99
Exposure Unit: BK__SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	6 / 6	6 / 6	100%	--	--	8,200	27,000	13,867	6,701	Lognormal	21,576	21,576		27,733	[CEB]
Arsenic	µg/g	4 / 6	4 / 6	67%	13	13	20	39	21	13	Normal	32	32		42	[CEB]
Barium	µg/g	6 / 6	6 / 6	100%	--	--	24	40	32	6.0	Normal	37	37		64	[CEB]
Beryllium	µg/g	4 / 6	4 / 6	67%	0.25	0.25	0.39	0.83	0.40	0.26	Normal	0.62	0.62		0.80	[CEB]
Calcium	µg/g	6 / 6	6 / 6	100%	--	--	239	4,610	1,238	1,685	Lognormal	11,707	4,610	#	2,475	[CEB]
Chromium	µg/g	5 / 6	5 / 6	83%	32	32	17	34	23	6.6	Normal	29	29		46	[CEB]
Cobalt	µg/g	3 / 6	3 / 6	50%	2.5	2.5	3.5	8.0	3.5	2.8	Normal	5.8	5.8		7.0	[CEB]
Copper	µg/g	6 / 6	6 / 6	100%	--	--	7.2	22	13	5.3	Normal	17	17		26	[CEB]
Iron	µg/g	6 / 6	6 / 6	100%	--	--	19,000	32,000	26,000	4,336	Normal	29,567	29,567		52,000	[CEB]
Lead	µg/g	1 / 6	1 / 6	17%	10.0	10.0	16	16	6.8	4.4	Lognormal	12	12		14	[CEB]
Magnesium	µg/g	6 / 6	6 / 6	100%	--	--	369	1,300	700	358	Normal	994	994		1,399	[CEB]
Manganese	µg/g	6 / 6	6 / 6	100%	--	--	40	600	341	217	Normal	519	519		682	[CEB]
Mercury	µg/g	1 / 6	1 / 6	17%	0.087	0.087	0.14	0.14	0.060	0.041	Lognormal	0.11	0.11		0.12	[CEB]
Nickel	µg/g	4 / 6	4 / 6	67%	7.5	7.5	11	18	11	5.9	Normal	15	15		21	[CEB]
Potassium	µg/g	6 / 6	6 / 6	100%	--	--	387	860	662	220	Normal	843	843		1,324	[CEB]
Vanadium	µg/g	6 / 6	6 / 6	100%	--	--	44	56	48	4.4	Normal	52	52		96	[CEB]
Zinc	µg/g	4 / 6	4 / 6	67%	23	32	30	73	35	23	Normal	54	54		71	[CEB]
Acetone	µg/g	2 / 6	2 / 6	33%	0.024	0.045	0.037	1.4	0.25	0.56	Lognormal	36	1.4	#	--	[CEB]
Nitrate	µg/g	2 / 2	2 / 2	100%	--	--	1.1	378	190	--	Undetermined	--	378	#	--	[CEB]
Phosphate	µg/g	1 / 2	1 / 2	50%	5.0	5.0	63	63	33	--	Undetermined	--	63	#	--	[CEB]
Toluene	µg/g	1 / 6	1 / 6	17%	0.0025	0.0025	0.0080	0.0080	0.0024	0.0028	Lognormal	0.0071	0.0071		--	[CEB]
Total Organic Carbon	µg/g	4 / 6	4 / 6	67%	1000	1000	1,830	6,830	2,770	2,398	Normal	4,743	4,743		--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.

[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).

[c] CRL - contract reporting limit.

[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).

[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.

[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.

[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.

-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-15. Summary Statistics and Exposure Point Concentrations for Soil (>10 ft BLS) at Study Area BK - Background
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 12:18:04 PM
Run Date: 3/31/99
Exposure Unit: BK__SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	6 / 6	6 / 6	100%	--	--	6,200	22,000	13,783	6,337	Normal	18,997	18,997		27,567	[CEB]
Arsenic	µg/g	5 / 6	5 / 6	83%	13	13	21	37	26	12	Normal	36	36		52	[CEB]
Barium	µg/g	6 / 6	6 / 6	100%	--	--	9.7	37	21	11	Normal	30	30		41	[CEB]
Beryllium	µg/g	3 / 6	3 / 6	50%	0.25	0.25	0.45	1.1	0.45	0.41	Normal	0.79	0.79		0.89	[CEB]
Calcium	µg/g	3 / 6	3 / 6	50%	109	109	188	220	128	82	Normal	196	196		257	[CEB]
Chromium	µg/g	6 / 6	6 / 6	100%	--	--	14	71	26	22	Lognormal	56	56		53	[CEB]
Cobalt	µg/g	6 / 6	6 / 6	100%	--	--	5.3	71	29	31	Lognormal	418	71	#	58	[CEB]
Copper	µg/g	6 / 6	6 / 6	100%	--	--	10	51	28	17	Normal	42	42		56	[CEB]
Iron	µg/g	6 / 6	6 / 6	100%	--	--	18,000	42,000	28,500	9,375	Normal	36,213	36,213		57,000	[CEB]
Lead	µg/g	4 / 6	4 / 6	67%	10.0	10.0	18	24	16	8.8	Normal	23	23		32	[CEB]
Magnesium	µg/g	6 / 6	6 / 6	100%	--	--	196	754	434	210	Normal	606	606		867	[CEB]
Manganese	µg/g	6 / 6	6 / 6	100%	--	--	64	1,800	665	741	Normal	1,275	1,275		1,331	[CEB]
Mercury	µg/g	3 / 6	3 / 6	50%	0.087	0.087	0.12	0.69	0.18	0.25	Lognormal	1.5	0.69	#	0.36	[CEB]
Nickel	µg/g	5 / 6	5 / 6	83%	7.5	7.5	10	52	23	20	Normal	40	40		46	[CEB]
Potassium	µg/g	6 / 6	6 / 6	100%	--	--	366	1,160	603	292	Lognormal	955	955		1,206	[CEB]
Vanadium	µg/g	6 / 6	6 / 6	100%	--	--	32	62	46	10	Normal	54	54		92	[CEB]
Zinc	µg/g	3 / 6	3 / 6	50%	30	93	43	121	52	38	Normal	84	84		104	[CEB]
Acetone	µg/g	1 / 6	1 / 6	17%	0.022	0.086	1.3	1.3	0.24	0.52	Lognormal	32	1.3	#	--	[CEB]
Toluene	µg/g	1 / 6	1 / 6	17%	0.0025	0.0025	0.0022	0.0022	0.0014	0.00039	Lognormal	0.0018	0.0018		--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

4.5.3 Study Area 2 – Smokeless Powder Facility

Study Area 2 is the Smokeless Powder Facility (cannon and rifle powder), most of which originally was located in the Leaseback Area south of Area B. To produce rifle and cannon powder, the following additives were mixed with nitro-cellulose in varying amounts, depending on the required powder specifications: diphenylamine to stabilize the nitrate ester groups, dibutyl phthalate as a plasticizer, and 2,4-DNT to control the burning rate. During a previous environmental survey (ESE 1981), 2,4-DNT was detected in soil samples.

Forty soil sampling locations were established at Study Area 2 during Phase 1 of the Supplemental RI. Surface soil samples were collected from all soil sampling locations and were screened for explosives in a field laboratory. Surface soil samples collected from 8 of the 40 screening locations were submitted for confirmatory analysis. Four soil borings were drilled and nine subsurface soil samples were collected for laboratory confirmatory analysis. The confirmatory samples were analyzed for metals, explosives, VOCs, and SVOCs. During Phase 2, five borings were drilled for collection of screening soil and in situ groundwater samples. A soil sample was not collected from one of the borings because rock was encountered. One sample was collected from one of the screening locations (SB-02-066) and sent to the laboratory for lead and explosives confirmatory analysis.

Sheets 4-5 and 4-6 present the screening results for surface and subsurface soils, respectively, for Study Area 2. **Sheets 4-7** and **4-8** present laboratory confirmatory results for lead and 2,4-DNT, respectively, in surface soils.

An explosives (2,4-DNT) hot spot was detected at surface soil sample location SS-02-5507 during Phase 1 of the Supplemental RI. 2,4-DNT was detected at this location at 26,100 µg/g. Based on SAIC's results, Roy F. Weston conducted a sampling program in September 1996 to delineate the extent of contamination around the hot spot at Study Area 2 so that remediation of the area could be conducted. The area was sampled by Roy F. Weston on 50-foot grids and grab samples were screened for explosives in an onsite field laboratory. Ten grab samples were collected from the gridded area around SS-02-5507 and screened in the field. Two confirmatory samples, each of which were composites of five grab samples, were submitted for laboratory confirmatory analysis. Confirmatory samples were analyzed for explosives and total lead.

Neither 2,4-DNT nor any other explosives were detected during confirmatory analysis of two samples from Study Area 2. The excavation criterion for 2,4-DNT was 356 ppm. Total lead was detected at a maximum concentration of 13.2 ppm, which was well below the lead excavation criterion of 500 ppm. Roy F. Weston's analytical results indicated that concentrations greater than excavation criteria were not present at Study Area 2. However, to be conservative, USACE directed Roy F. Weston to excavate the hot spot grid (50 by 50 feet) within which SS-02-5507 was located. The proposed excavation depth was 2 feet BLS, resulting in an excavation volume of

185 cubic yards. **Figure 4-17** shows the area of soils that have been excavated and remediated at Study Area 2. Following remediation, confirmatory samples were collected just below the excavation depth to verify that remediation was adequate (Weston 1996e).

The Supplemental RI data summary tables for Study Area 2 are presented in Appendix K. The remediation data collected by Roy F. Weston are presented in Appendix L. For the purposes of statistical analysis, the Supplemental RI data collected from the location that subsequently was remediated (SS-02-5507) were removed from the data set. The Roy F. Weston post-excavation confirmatory data (02EXCF1278) were included in the statistical analysis.

Summary statistics for the soils remaining in Study Area 2 are shown in **Tables 4-16** through **4-18**. These tables present statistics for chemicals detected in the surface or subsurface soils remaining at Study Area 2 after the remedial activities.

Figure 4-17 shows the locations where the general contaminant group CEBs (i.e., metals, SVOCs, VOCs, and explosives) were detected in the soils remaining at Study Area 2 after remediation. The lack of quadrants in a circle indicates that a soil sample was not collected at that interval.

The text boxes provide the maximum concentration of each metal that exceeded background concentrations or each organic compound that was detected for each interval sampled. Boxes for intervals where metals were not detected at concentrations above background or where organics were not detected are blank.

Metals—Nineteen metals (listed in the adjacent box) exceeded background in Study Area 2 soils. The maximum surface soil concentrations of copper, iron, lead, mercury, nickel, and zinc were detected in sample SS-02-0000. Only one surface soil sample (SS-02-0015) was co-located with a soil boring (SB-02-004). Concentrations of CEB metals generally increased slightly with depth at this location. The maximum deep subsurface concentrations of lead and thallium were detected in the 25-foot BLS interval at this location. The maximum deep subsurface concentration of iron was detected in the 25-foot BLS interval at location SB-02-001.

Maximum Concentrations*			
Analyte (µg/g)	0-<1ft	1-10ft	>10ft
Aluminum	**36,000**	38,000	29,000
Arsenic	24.9		
Barium	419	369	68.7
Beryllium	5	4.37	3.69
Calcium	82,000	82,000	7,700
Chromium	118		
Cobalt		7.67	
Copper	**46.1**		
Iron	**43,000**	53,000	**66,000**
Lead	**213**	40.8	**54.2**
Magnesium	13,000	14,000	3,930
Manganese	1,900	1,700	1,700
Mercury	**0.318**	0.306	
Nickel	**26.5**		
Potassium	4,070	3,730	
Sodium	517	**384**	**165**
Thallium			**20.2**
Vanadium	78.1		
Zinc	**330**		

*Metals determined to exceed background based on ANOVA evaluation are shown in bold.

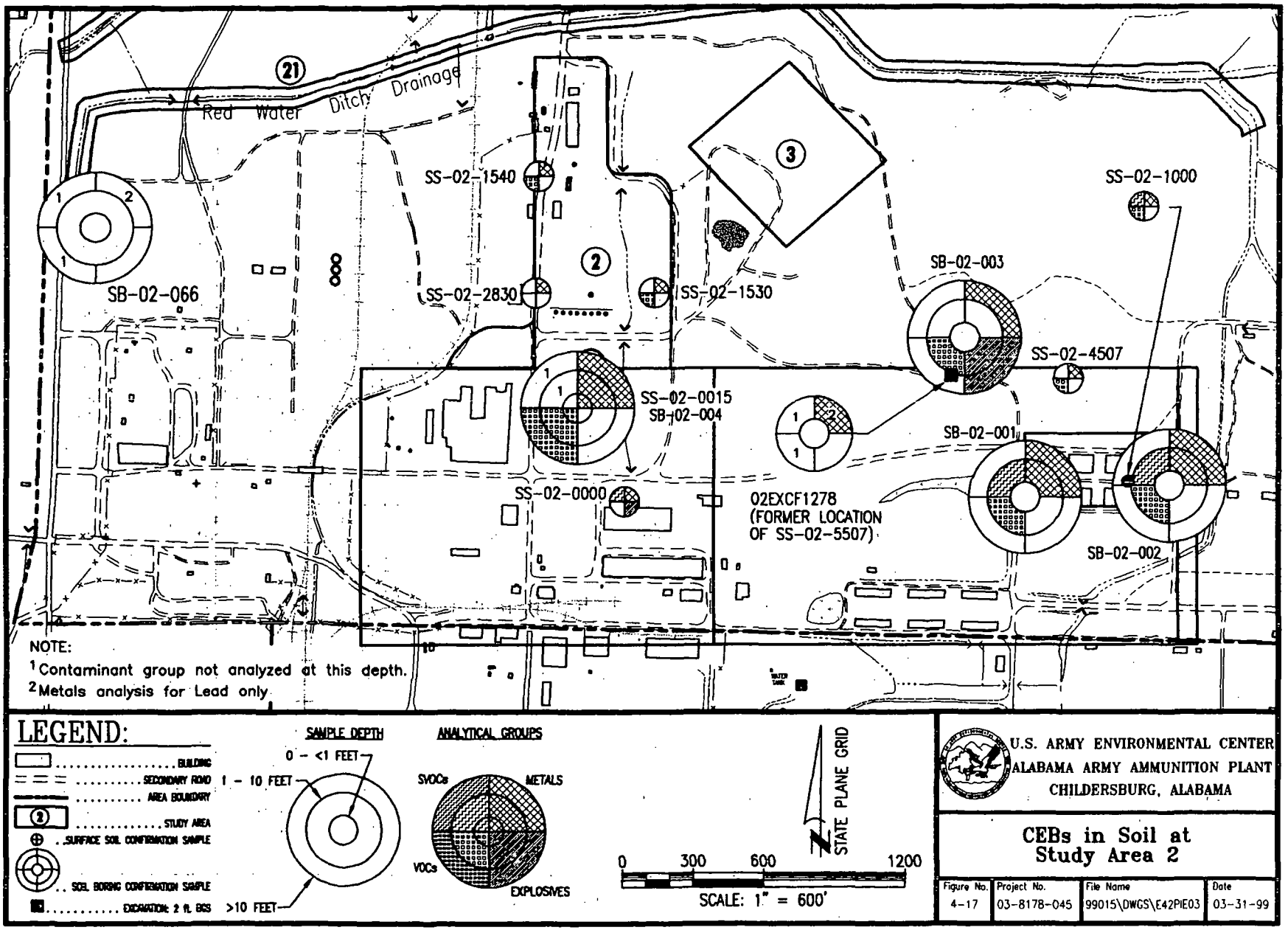

21
Red Water Ditch Drainage
3
2
SS-02-1540
SS-02-1000
SB-02-066
SS-02-2830
SS-02-1530
SB-02-003
SS-02-4507
SS-02-0015
SB-02-004
SB-02-001
SS-02-0000
02EXCF1278
(FORMER LOCATION
OF SS-02-5507)
SB-02-002
NOTE:
1 Contaminant group not analyzed at this depth.
2 Metals analysis for Lead only
LEGEND:
BUILDING
SECONDARY ROAD
AREA BOUNDARY
STUDY AREA
SURFACE SOIL CONFIRMATION SAMPLE
SOIL BORING CONFIRMATION SAMPLE
EXCAVATION: 2 ft. BGS
SAMPLE DEPTH
0 - <1 FEET
1 - 10 FEET
>10 FEET
ANALYTICAL GROUPS
SVOCs
METALS
VOCs
EXPLOSIVES
STATE PLANE GRID
0 300 600 1200
SCALE: 1" = 600'
U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA
CEBs in Soil at
Study Area 2
Figure No. 4-17
Project No. 03-8178-045
File Name 99015\DWGS\E42PIE03
Date 03-31-99

Table 4-16. Summary Statistics and Exposure Point Concentrations for Soil (0-<1 ft BLS) at Study Area 2 - Smokeless Powder Facility
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:10:16 PM
Run Date: 3/29/99
Exposure Unit: 02__SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	7 / 7	7 / 7	100%	--	--	11,000	36,000	19,571	8,364	Normal	25,714	25,714		20,277	[CEB]
Arsenic	µg/g	5 / 7	5 / 7	71%	13	13	14	25	15	7.2	Normal	21	21		15	[CEB][ANOVA]
Barium	µg/g	7 / 7	7 / 7	100%	--	--	56	419	184	126	Normal	277	277		124	[CEB][ANOVA]
Beryllium	µg/g	7 / 7	7 / 7	100%	--	--	0.64	5.0	1.8	1.5	Lognormal	4.8	4.8		0.82	[CEB][ANOVA]
Calcium	µg/g	7 / 7	7 / 7	100%	--	--	2,110	82,000	20,547	28,217	Lognormal	279,222	82,000	#	4,960	[CEB][ANOVA]
Chromium	µg/g	3 / 7	3 / 7	43%	22	67	20	118	36	37	Lognormal	97	97		54	[CEB][ANOVA]
Cobalt	µg/g	2 / 7	2 / 7	29%	2.5	2.5	6.2	7.6	2.9	2.8	Lognormal	8.7	7.6	#	14	[bk]
Copper	µg/g	7 / 7	7 / 7	100%	--	--	9.9	46	18	12	Lognormal	30	30		13	[CEB]
Iron	µg/g	7 / 7	7 / 7	100%	--	--	28,000	43,000	36,857	5,460	Normal	40,867	40,867		37,560	[CEB]
Lead	µg/g	7 / 7	7 / 7	100%	--	--	27	213	71	68	Lognormal	199	199		34	[CEB]
Magnesium	µg/g	7 / 7	7 / 7	100%	--	--	535	13,000	3,491	4,330	Lognormal	24,557	13,000	#	1,189	[CEB][ANOVA]
Manganese	µg/g	7 / 7	7 / 7	100%	--	--	400	1,900	883	569	Normal	1,300	1,300		1,730	[CEB][ANOVA]
Mercury	µg/g	4 / 7	4 / 7	57%	0.087	0.087	0.12	0.32	0.12	0.098	Lognormal	0.32	0.32	#	0.056	[CEB]
Nickel	µg/g	7 / 7	7 / 7	100%	--	--	10.0	27	14	5.6	Lognormal	19	19		9.4	[CEB]
Potassium	µg/g	7 / 7	7 / 7	100%	--	--	689	4,070	1,563	1,179	Lognormal	3,186	3,186		680	[CEB][ANOVA]
Sodium	µg/g	5 / 7	5 / 7	71%	50	50	84	517	162	169	Lognormal	1,207	517	#	501	[CEB][ANOVA]
Vanadium	µg/g	7 / 7	7 / 7	100%	--	--	42	78	54	13	Normal	64	64		76	[CEB][ANOVA]
Zinc	µg/g	7 / 7	7 / 7	100%	--	--	41	330	92	106	Lognormal	221	221		36	[CEB]
1,3-Dinitrobenzene	µg/g	1 / 7	1 / 7	14%	0.068	0.068	0.083	0.083	0.041	0.019	Lognormal	0.055	0.055		--	[CEB]
2,4-Dinitrotoluene	µg/g	1 / 7	1 / 7	14%	0.054	0.056	0.48	0.48	0.091	0.17	Lognormal	0.45	0.45		--	[CEB]
2-Methylnaphthalene	µg/g	1 / 7	1 / 7	14%	0.17	0.17	1.6	1.6	0.30	0.57	Lognormal	1.6	1.6		--	[CEB]
4-Methyl Phenol	µg/g	1 / 7	1 / 7	14%	0.18	0.18	0.22	0.22	0.11	0.049	Lognormal	0.15	0.15		--	[CEB]
Acenaphthene	µg/g	1 / 7	1 / 7	14%	0.27	0.27	30	30	4.4	11	Lognormal	817	30	#	--	[CEB]
Anthracene	µg/g	2 / 7	2 / 7	29%	0.17	0.17	0.31	30	4.4	11	Lognormal	3,179	30	#	--	[CEB]
Benzo(a)anthracene	µg/g	2 / 7	2 / 7	29%	0.17	0.17	1.2	90	13	34	Lognormal	247,244	90	#	--	[CEB]
Benzo(a)pyrene	µg/g	1 / 7	1 / 7	14%	0.24	0.24	90	90	13	34	Lognormal	61,432	90	#	--	[CEB]
Benzo(b)fluoranthene	µg/g	2 / 7	2 / 7	29%	0.73	0.73	1.6	90	13	34	Lognormal	3,440	90	#	--	[CEB]
Benzo(g,h,i)perylene	µg/g	2 / 7	2 / 7	29%	0.25	0.25	1.3	20	3.1	7.5	Lognormal	545	20	#	--	[CEB]
Benzo(k)fluoranthene	µg/g	2 / 7	2 / 7	29%	0.40	0.40	0.67	50	7.4	19	Lognormal	1,765	50	#	--	[CEB]
Chrysene	µg/g	2 / 7	2 / 7	29%	0.27	0.27	1.4	80	12	30	Lognormal	50,628	80	#	--	[CEB]
Dibenzo(a,h)anthracene	µg/g	1 / 7	1 / 7	14%	0.27	0.27	20	20	3.0	7.5	Lognormal	228	20	#	--	[CEB]
Dibenzofuran	µg/g	1 / 7	1 / 7	14%	0.17	0.17	4.3	4.3	0.69	1.6	Lognormal	10.0	4.3	#	--	[CEB]
Fluoranthene	µg/g	2 / 7	2 / 7	29%	0.17	0.17	2.8	200	29	75	Lognormal	8.36E+06	200	#	--	[CEB]
Fluorene	µg/g	1 / 7	1 / 7	14%	0.17	0.17	9.0	9.0	1.4	3.4	Lognormal	58	9.0	#	--	[CEB]
Indeno(1,2,3-cd)pyrene	µg/g	2 / 7	2 / 7	29%	0.17	0.17	1.2	30	4.5	11	Lognormal	9,298	30	#	--	[CEB]
Naphthalene	µg/g	1 / 7	1 / 7	14%	0.17	0.17	3.4	3.4	0.56	1.3	Lognormal	6.1	3.4	#	--	[CEB]
Phenanthrene	µg/g	2 / 7	2 / 7	29%	0.17	0.17	1.4	90	13	34	Lognormal	283,052	90	#	--	[CEB]
Pyrene	µg/g	2 / 7	2 / 7	29%	0.97	0.97	2.2	80	12	30	Lognormal	1,274	80	#	--	[CEB]
Toluene	µg/g	5 / 7	5 / 7	71%	0.0025	0.0025	0.0017	0.024	0.0052	0.0083	Lognormal	0.026	0.024	#	--	[CEB]
Total Organic Carbon	µg/g	7 / 7	7 / 7	100%	--	--	27,200	165,000	82,057	45,759	Normal	115,665	115,665		--	[CEB]

Table 4-16. Summary Statistics and Exposure Point Concentrations for Soil (0-<1 ft BLS) at Study Area 2 - Smokeless Powder Facility (Continued)
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:10:16 PM
Run Date: 3/29/99
Exposure Unit: 02__SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]	2 x BK Mean[d]	Background Comparison[g]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-17. Summary Statistics and Exposure Point Concentrations for Soil (1-10 ft BLS) at Study Area 2 - Smokeless Powder Facility
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:10:16 PM
Run Date: 3/29/99
Exposure Unit: 02__SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	5 / 5	5 / 5	100%	--	--	13,000	38,000	19,800	10,474	Lognormal	37,026	37,026		27,733	[CEB][ANOVA]
Arsenic	µg/g	2 / 5	2 / 5	40%	13	13	16	26	12	8.6	Normal	20	20		42	[bk]
Barium	µg/g	5 / 5	5 / 5	100%	--	--	25	369	124	142	Lognormal	2,615	369	#	64	[CEB][ANOVA]
Beryllium	µg/g	4 / 5	4 / 5	80%	0.25	0.25	0.67	4.4	1.4	1.7	Lognormal	90	4.4	#	0.80	[CEB][ANOVA]
Calcium	µg/g	5 / 5	5 / 5	100%	--	--	148	82,000	20,054	35,063	Lognormal	9.42E+10	82,000	#	2,475	[CEB][ANOVA]
Chromium	µg/g	1 / 5	1 / 5	20%	15	33	41	41	19	13	Lognormal	53	41	#	46	[bk]
Cobalt	µg/g	4 / 5	4 / 5	80%	2.5	2.5	5.2	7.7	5.3	2.5	Normal	7.6	7.6		7.0	[CEB][ANOVA]
Copper	µg/g	4 / 5	4 / 5	80%	3.4	3.4	9.3	23	12	7.9	Normal	20	20		26	[bk]
Iron	µg/g	5 / 5	5 / 5	100%	--	--	9,200	53,000	32,640	16,339	Normal	48,217	48,217		52,000	[CEB][ANOVA]
Lead	µg/g	5 / 6	5 / 6	83%	10.0	10.0	14	41	23	14	Normal	34	34		14	[CEB][ANOVA]
Magnesium	µg/g	5 / 5	5 / 5	100%	--	--	459	14,000	3,619	5,824	Lognormal	254,948	14,000	#	1,399	[CEB][ANOVA]
Manganese	µg/g	5 / 5	5 / 5	100%	--	--	108	1,700	566	655	Lognormal	10,584	1,700	#	682	[CEB][ANOVA]
Mercury	µg/g	1 / 5	1 / 5	20%	0.087	0.087	0.31	0.31	0.096	0.12	Lognormal	0.63	0.31	#	0.12	[CEB][ANOVA]
Nickel	µg/g	2 / 5	2 / 5	40%	7.5	7.5	14	16	8.3	6.2	Lognormal	38	16	#	21	[bk]
Potassium	µg/g	5 / 5	5 / 5	100%	--	--	364	3,730	1,281	1,407	Lognormal	12,299	3,730	#	1,324	[CEB][ANOVA]
Sodium	µg/g	3 / 5	3 / 5	60%	50	50	75	384	127	150	Lognormal	3,732	384	#	--	[CEB]
Vanadium	µg/g	5 / 5	5 / 5	100%	--	--	34	76	58	15	Normal	73	73		96	[bk]
Zinc	µg/g	2 / 5	2 / 5	40%	27	62	25	46	28	12	Normal	39	39		71	[bk]
2,4-Dinitrotoluene	µg/g	1 / 6	1 / 6	17%	0.056	0.21	99	99	17	41	Lognormal	2.24E+09	99	#	--	[CEB]
2,6-Dinitrotoluene	µg/g	1 / 6	1 / 6	17%	0.079	0.22	0.15	0.15	0.071	0.050	Lognormal	0.16	0.15	#	--	[CEB]
Acetone	µg/g	2 / 5	2 / 5	40%	0.045	0.045	0.13	1.1	0.26	0.47	Lognormal	328	1.1	#	--	[CEB]
Benzo(a)anthracene	µg/g	2 / 3	2 / 3	67%	0.17	0.17	0.17	0.72	--	--	Undetermined	--	0.72	#	--	[CEB]
Benzo(a)pyrene	µg/g	1 / 3	1 / 3	33%	0.24	0.24	0.85	0.85	--	--	Undetermined	--	0.85	#	--	[CEB]
Benzo(b)fluoranthene	µg/g	1 / 3	1 / 3	33%	0.73	0.73	1.3	1.3	--	--	Undetermined	--	1.3	#	--	[CEB]
Benzo(g,h,i)perylene	µg/g	1 / 3	1 / 3	33%	0.25	0.25	0.40	0.40	--	--	Undetermined	--	0.40	#	--	[CEB]
Chrysene	µg/g	1 / 3	1 / 3	33%	0.27	0.27	0.93	0.93	--	--	Undetermined	--	0.93	#	--	[CEB]
Fluoranthene	µg/g	1 / 3	1 / 3	33%	0.17	0.17	1.8	1.8	--	--	Undetermined	--	1.8	#	--	[CEB]
Indeno(1,2,3-cd)pyrene	µg/g	1 / 3	1 / 3	33%	0.17	0.17	0.49	0.49	--	--	Undetermined	--	0.49	#	--	[CEB]
Methylene Chloride	µg/g	4 / 5	4 / 5	80%	0.0062	0.0062	0.0050	0.0075	0.0053	0.0016	Normal	0.0068	0.0068		--	[CEB]
Phenanthrene	µg/g	2 / 3	2 / 3	67%	0.17	0.17	0.29	0.50	--	--	Undetermined	--	0.50	#	--	[CEB]
Pyrene	µg/g	1 / 3	1 / 3	33%	0.97	0.97	1.6	1.6	--	--	Undetermined	--	1.6	#	--	[CEB]
Total Organic Carbon	µg/g	5 / 5	5 / 5	100%	--	--	2,290	15,900	8,592	5,821	Normal	14,142	14,142		--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-18. Summary Statistics and Exposure Point Concentrations for Soil (>10 ft BLS) at Study Area 2 - Smokeless Powder Facility Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:10:16 PM
Run Date: 3/29/99
Exposure Unit: 02__SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	4 / 4	4 / 4	100%	--	--	11,000	29,000	20,250	7,632	Normal	29,231	29,000	#	27,567	[CEB][ANOVA]
Arsenic	µg/g	3 / 4	3 / 4	75%	13	13	22	43	24	15	Normal	42	42		52	[bk]
Barium	µg/g	4 / 4	4 / 4	100%	--	--	23	69	51	20	Normal	74	69	#	41	[CEB][ANOVA]
Beryllium	µg/g	4 / 4	4 / 4	100%	--	--	1.0	3.7	2.3	1.1	Normal	3.6	3.6		0.89	[CEB][ANOVA]
Calcium	µg/g	4 / 4	4 / 4	100%	--	--	147	7,700	2,417	3,553	Lognormal	1.29E+08	7,700	#	257	[CEB][ANOVA]
Chromium	µg/g	1 / 4	1 / 4	25%	15	38	25	25	16	7.3	Normal	25	25	#	53	[bk]
Cobalt	µg/g	3 / 4	3 / 4	75%	2.5	2.5	11	52	20	22	Normal	46	46		58	[bk]
Copper	µg/g	4 / 4	4 / 4	100%	--	--	24	27	26	1.1	Normal	27	27	#	56	[bk]
Iron	µg/g	4 / 4	4 / 4	100%	--	--	50,000	66,000	58,750	6,898	Normal	66,867	66,000	#	57,000	[CEB]
Lead	µg/g	5 / 5	5 / 5	100%	--	--	29	54	40	11	Normal	51	51		32	[CEB]
Magnesium	µg/g	4 / 4	4 / 4	100%	--	--	373	3,930	1,438	1,683	Lognormal	120,607	3,930	#	867	[CEB][ANOVA]
Manganese	µg/g	4 / 4	4 / 4	100%	--	--	410	1,700	905	556	Normal	1,559	1,559		1,331	[CEB][ANOVA]
Mercury	µg/g	3 / 4	3 / 4	75%	0.087	0.087	0.11	0.20	0.12	0.063	Normal	0.20	0.20		0.36	[bk]
Nickel	µg/g	4 / 4	4 / 4	100%	--	--	17	31	24	5.6	Normal	31	31		46	[bk]
Potassium	µg/g	4 / 4	4 / 4	100%	--	--	306	1,200	734	387	Normal	1,189	1,189		1,206	[bk]
Sodium	µg/g	2 / 4	2 / 4	50%	50	50	77	165	73	66	Normal	151	151		--	[CEB]
Thallium	µg/g	1 / 4	1 / 4	25%	13	13	20	20	9.7	7.0	Lognormal	40	20	#	--	[CEB]
Vanadium	µg/g	4 / 4	4 / 4	100%	--	--	53	83	69	16	Normal	88	83	#	92	[bk]
Zinc	µg/g	2 / 4	2 / 4	50%	74	79	47	60	46	10	Normal	58	58		104	[bk]
2,4-Dinitrotoluene	µg/g	1 / 5	1 / 5	20%	0.056	0.062	0.37	0.37	0.096	0.15	Lognormal	2.1	0.37	#	--	[CEB]
Methylene Chloride	µg/g	1 / 4	1 / 4	25%	0.0062	0.0062	0.0046	0.0046	0.0035	0.00075	Lognormal	0.0046	0.0046	#	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Lead concentrations at Study Area 2 ranged from nondetect (SB-02-003; 1 foot BLS) to 213 µg/g (SS-02-0000). Lead concentrations exceeded background in four surface soil samples and in all soil boring samples, except those collected at SB-02-003 and SB-02-066. Lead concentrations increased slightly with depth in samples collected from the soil borings.

Explosives—Forty surface soil and nine subsurface soil (from four borings) samples were screened for explosives during the Supplemental RI. Concentrations detected in all samples were less than 16 µg/g except for SS-02-5507, which was 200 µg/g (see Sheet 4-5). As discussed previously, soils in the area of location SS-02-5507 have been remediated. Two explosives (1,3-DNB and 2,4-DNT) were detected in confirmatory surface soil samples, and are listed in the adjacent box. These two explosives were detected only in one of the surface soil samples (SS-02-0000). Explosives were detected in samples from one (SB-02-003) of the borings at Study Area 2. 2,4-DNT and 2,6-DNT were detected in the shallow subsurface soil sample collected at location SB-02-0003. 2,4-DNT also was detected in the 25-foot BLS sample collected at this location. Both 2,4-DNT and 2,6-DNT, which were not detected in the 25-foot BLS sample, attenuated with depth.

Maximum Concentrations			
Analyte (µg/g)	0-<1ft	1-10ft	>10ft
1,3-DNB	0.0832		
2,4-DNT	0.475	99.3	0.366
2,6-DNT		0.154	

VOCs—Two VOCs (methylene chloride and toluene) were detected at low concentrations (near or below the CRL) in the soils sampled within Study Area 2 and are noted in the adjacent box. Toluene was detected in five surface soil samples and methylene chloride was detected in five soil boring samples. Methylene chloride was detected in subsurface soils in both the shallow subsurface interval and the deep subsurface interval. In addition, acetone was detected at a maximum concentration of 1.10 µg/g in the 10-foot BLS sample at location SB-02-002. Acetone was not detected in the 20-foot BLS sample from this location.

Maximum Concentrations			
Analyte (µg/g)	0-<1ft	1-10ft	>10ft
Acetone		1.10	
Methylene Chloride		0.0075	0.0046
Toluene	0.024		

SVOCs—Eighteen SVOCs (listed in the adjacent box) were detected in the soils at Study Area 2. SVOCs were detected in two surface soil samples (SS-02-0000 and SS-02-1000) and two shallow subsurface soil samples (SB-02-001 and SB-02-002). SVOCs were not detected in the deep subsurface soil samples. All 18 SVOCs

Maximum Concentrations			
Analyte (µg/g)	0-<1ft	1-10ft	>10ft
Acenaphthene	30		
Anthracene	30		
Benzo(a)anthracene	90	0.72	
Benzo(k)fluoranthene	50		
Benzo(a)pyrene	90	0.85	
Benzo(b)fluoranthene	90	1.3	
Benzo(g,h,i)perylene	20	0.4	
Chrysene	80	0.93	
Dibenzo(a,h)anthracene	20		
Dibenzofuran	4.3		
Fluoranthene	200	1.8	
Fluorene	9		
Indeno(1,2,3-cd)pyrene	30	0.49	
2-Methylnaphthalene	1.6		
4-Methylphenol	0.22		
Naphthalene	3.4		
Phenanthrene	90	0.5	
Pyrene	80	1.6	

were detected in sample SS-02-0000 and 10 SVOCs were detected in sample SS-02-1000. All of the SVOCs detected in the two shallow subsurface soil samples were PAHs; nine PAHs were detected in the 1-foot BLS sample at SB-02-001, and two PAHs were detected in the 1-foot BLS sample at SB-02-002. PAHs in the Study Area 2 soils are likely to be related to the burning of buildings in the area.

Summary—Metals, explosives, VOCs, and SVOCs were detected above background concentrations in soils sampled within Study Area 2. The distribution of chemicals appears to be random and could not be identified with a particular source. Metals exceeding background were randomly distributed throughout the Study Area 2 soils. Lead concentrations slightly exceeded background at a majority of the Study Area 2 sampling locations.

The screening and confirmatory results collected during Phase 1 of the Supplemental RI for explosives resulted in remediation of the soils around sample SS-02-5507 by Roy F. Weston. A total of 185 cubic yards of soil were excavated and remediated. Supplemental RI and remediation confirmatory sampling indicate that no explosives remain in the soil at concentrations greater than 100 µg/g. Explosives (1,3-DNB, 2,4-DNT, and 2,6-DNT) were detected at lower concentrations in one surface soil sample and two subsurface soil samples from the same boring.

Two VOCs were detected in the soils at concentrations near or below the CRL, and acetone was detected at a maximum concentration of 1.1 µg/g. These VOCs are not suspected to be attributable to site activities. SVOCs were detected in the surface and shallow subsurface soils at random locations throughout Study Area 2. SVOCs were not present in deep subsurface soils. The presence of PAHs probably is related to the burning of buildings in the area.

4.5.4 Study Area 3 – Sanitary Landfill and Lead Facility

According to the Installation Assessment (DA 1978), Study Area 3, the Sanitary Landfill and Lead Facility, was used for open burning of refuse, waste, dunnage, inert materials, and rejected explosives waste; flashing of contaminated metals; and small demilitarization projects, beginning in 1941.

The northern portion of the area contained trenches that received ash and residue and were covered with soil. The trenches also may have received cans, paper, bottles, or used clothing that were not burned prior to placement (DA 1978). Lead, mercury, TNT, nitrobenzene, and 1,3,5-TNB were detected in soils at Study Area 3 during the environmental survey (ESE 1981).

During Phase 1 of the Supplemental RI, Study Area 3 was gridded and eight soil samples were collected from the surface and screened for explosives and lead. Surface soil samples were collected from three locations and submitted for confirmatory analysis. Three soil borings were drilled and samples were collected at 5-foot intervals. These were screened for explosives in the field and for lead on a quick-turnaround basis at the offsite laboratory. Nine soil samples were

collected from the three borings and sent to the laboratory for confirmatory analysis. Soil samples sent to the laboratory were analyzed for metals, explosives, VOCs, SVOCs, and pesticides/PCBs. Four samples (two surface and two subsurface) were analyzed for hexavalent chromium. During Phase 2, two additional surface soil samples were collected from location SS-03-0020. Both samples were analyzed at the laboratory for aluminum and lead.

Appendix K presents data summary tables for Study Area 3. **Tables 4-19** through **4-21** present summary statistics for Study Area 3 soils. **Figure 4-18** depicts the locations where the general contaminant group CEBs (metals, SVOCs, VOCs, and explosives) were detected in Study Area 3 soils. The lack of quadrants in a circle indicates that a sample was not collected at that interval. Sheets 4-5 and 4-6 present the screening results for surface and subsurface soils, respectively. Sheets 4-7 and 4-8 present laboratory confirmatory results for lead and 2,4-DNT, respectively, in surface soils.

Metals—Eighteen metals exceeded background concentrations in soils (listed in the adjacent box) from Study Area 3. The highest concentrations of 8 of 11 surface soil CEB metals (aluminum, arsenic, cobalt, iron, lead, mercury nickel, and vanadium) occurred near the middle of the study area at SS-03-0020 and SS-03-1000 (see Figure 4-18). The maximum concentrations of barium, beryllium, and copper were detected at SS-03-0010, located in the southern portion of the study area.

The maximum concentration of beryllium in deep subsurface soils was detected at SB-03-005, which was co-located with SS-03-0010. The maximum concentration of iron in deep subsurface soils was detected at SB-03-006, which was co-located with SS-03-0020.

	Maximum Concentrations*		
Analyte (µg/g)	0-<1ft**	1-10ft	>10ft**
Aluminum	29,000		
Arsenic	43.2		
Barium	307		
Beryllium	3.54	1.11	1.23
Calcium	48,000	3,890	584
Chromium		49.4	
Cobalt	27.7	10.3	
Copper	65.3		
Iron	61,000	65,000	60,000
Lead	320	201	
Magnesium	8,300		
Manganese		740	
Mercury	0.113	0.155	
Nickel	20.5		
Potassium	2,990		
Sodium		**360**	70
Vanadium	80.7		
Zinc		100	

* Metals determined to exceed background based on ANOVA evaluation are shown in bold.

** ANOVA evaluation was not conducted because there are fewer than four samples in the data set.

Maximum surface soil lead concentrations were 278, 320, and 38.4 µg/g from SS-03-0010, SS-03-0020, and SS-03-1000, respectively (see Sheet 4-7). Lower concentrations of lead, which were <40 µg/g, were detected in borings from locations coinciding with SS-03-0010 and SS-03-0020 (SB-03-005 and SB-03-006, respectively). In subsurface samples, the highest lead concentration was 201 µg/g from the 5-foot interval of boring SB-03-007, at the northern end of the study area.

Table 4-19. Summary Statistics and Exposure Point Concentrations for Soil (0-<1 ft BLS) at Study Area 3 - Sanitary Landfill and Lead Facility
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:15:07 PM
Run Date: 3/29/99
Exposure Unit: 03__SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	5 / 5	3 / 3	100%	--	--	15,100	29,000	--	--	Undetermined	--	29,000	#	20,277	[CEB]
Arsenic	µg/g	3 / 3	3 / 3	100%	--	--	30	43	--	--	Undetermined	--	43	#	15	[CEB]
Barium	µg/g	3 / 3	3 / 3	100%	--	--	38	307	--	--	Undetermined	--	307	#	124	[CEB]
Beryllium	µg/g	3 / 3	3 / 3	100%	--	--	0.66	3.5	--	--	Undetermined	--	3.5	#	0.82	[CEB]
Calcium	µg/g	3 / 3	3 / 3	100%	--	--	1,210	48,000	--	--	Undetermined	--	48,000	#	4,960	[CEB]
Cobalt	µg/g	3 / 3	3 / 3	100%	--	--	23	28	--	--	Undetermined	--	28	#	14	[CEB]
Copper	µg/g	3 / 3	3 / 3	100%	--	--	19	65	--	--	Undetermined	--	65	#	13	[CEB]
Iron	µg/g	3 / 3	3 / 3	100%	--	--	38,000	61,000	--	--	Undetermined	--	61,000	#	37,560	[CEB]
Lead	µg/g	5 / 5	3 / 3	100%	--	--	38	320	--	--	Undetermined	--	320	#	34	[CEB]
Magnesium	µg/g	3 / 3	3 / 3	100%	--	--	770	8,300	--	--	Undetermined	--	8,300	#	1,189	[CEB]
Manganese	µg/g	3 / 3	3 / 3	100%	--	--	440	1,100	--	--	Undetermined	--	1,100	#	1,730	[bk]
Mercury	µg/g	1 / 3	1 / 3	33%	0.087	0.087	0.11	0.11	--	--	Undetermined	--	0.11	#	0.056	[CEB]
Nickel	µg/g	3 / 3	3 / 3	100%	--	--	15	21	--	--	Undetermined	--	21	#	9.4	[CEB]
Potassium	µg/g	3 / 3	3 / 3	100%	--	--	900	2,990	--	--	Undetermined	--	2,990	#	680	[CEB]
Sodium	µg/g	2 / 3	2 / 3	67%	50	50	105	332	--	--	Undetermined	--	332	#	501	[bk]
Vanadium	µg/g	3 / 3	3 / 3	100%	--	--	53	81	--	--	Undetermined	--	81	#	76	[CEB]
2,4-Dinitrotoluene	µg/g	1 / 3	1 / 3	33%	0.054	0.054	0.095	0.095	--	--	Undetermined	--	0.095	#	--	[CEB]
Acetone	µg/g	1 / 3	1 / 3	33%	0.045	0.045	0.026	0.026	--	--	Undetermined	--	0.026	#	--	[CEB]
Anthracene	µg/g	1 / 3	1 / 3	33%	0.17	0.17	0.15	0.15	--	--	Undetermined	--	0.15	#	--	[CEB]
Benzo(a)anthracene	µg/g	2 / 3	2 / 3	67%	0.17	0.17	0.53	0.73	--	--	Undetermined	--	0.73	#	--	[CEB]
Benzo(a)pyrene	µg/g	2 / 3	2 / 3	67%	0.24	0.24	0.46	0.73	--	--	Undetermined	--	0.73	#	--	[CEB]
Benzo(b)fluoranthene	µg/g	2 / 3	2 / 3	67%	0.73	0.73	0.64	0.94	--	--	Undetermined	--	0.94	#	--	[CEB]
Benzo(g,h,i)perylene	µg/g	2 / 3	2 / 3	67%	0.25	0.25	0.22	0.34	--	--	Undetermined	--	0.34	#	--	[CEB]
Benzo(k)fluoranthene	µg/g	1 / 3	1 / 3	33%	0.40	0.40	0.41	0.41	--	--	Undetermined	--	0.41	#	--	[CEB]
Chrysene	µg/g	2 / 3	2 / 3	67%	0.27	0.27	0.52	0.81	--	--	Undetermined	--	0.81	#	--	[CEB]
Fluoranthene	µg/g	2 / 3	2 / 3	67%	0.17	0.17	1.1	1.6	--	--	Undetermined	--	1.6	#	--	[CEB]
Indeno(1,2,3-cd)pyrene	µg/g	2 / 3	2 / 3	67%	0.17	0.17	0.18	0.35	--	--	Undetermined	--	0.35	#	--	[CEB]
Methylene Chloride	µg/g	1 / 3	1 / 3	33%	0.0062	0.0062	0.0081	0.0081	--	--	Undetermined	--	0.0081	#	--	[CEB]
Phenanthrene	µg/g	2 / 3	2 / 3	67%	0.17	0.17	0.54	0.72	--	--	Undetermined	--	0.72	#	--	[CEB]
Pyrene	µg/g	2 / 3	2 / 3	67%	0.97	0.97	0.65	1.2	--	--	Undetermined	--	1.2	#	--	[CEB]
Toluene	µg/g	1 / 3	1 / 3	33%	0.0025	0.0025	0.0062	0.0062	--	--	Undetermined	--	0.0062	#	--	[CEB]
Total Organic Carbon	µg/g	3 / 3	3 / 3	100%	--	--	6,300	57,200	--	--	Undetermined	--	57,200	#	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-20. Summary Statistics and Exposure Point Concentrations for Soil (1-10 ft BLS) at Study Area 3 - Sanitary Landfill and Lead Facility
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:15:07 PM
Run Date: 3/29/99
Exposure Unit: 03__SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	6 / 6	6 / 6	100%	--	--	3,300	26,000	16,550	8,216	Normal	23,308	23,308		27,733	[bk]
Arsenic	µg/g	2 / 6	2 / 6	33%	13	13	20	35	13	12	Lognormal	43	35	#	42	[bk]
Barium	µg/g	6 / 6	6 / 6	100%	--	--	20	53	37	14	Normal	48	48		64	[bk]
Beryllium	µg/g	6 / 6	6 / 6	100%	--	--	0.67	1.1	0.82	0.21	Lognormal	1.0	1.0		0.80	[CEB][ANOVA]
Calcium	µg/g	6 / 6	6 / 6	100%	--	--	371	3,890	1,294	1,324	Lognormal	5,595	3,890	#	2,475	[CEB][ANOVA]
Chromium	µg/g	5 / 6	5 / 6	83%	22	22	34	49	36	13	Normal	47	47		46	[CEB][ANOVA]
Cobalt	µg/g	4 / 6	4 / 6	67%	2.5	2.5	4.6	10	4.9	3.4	Normal	7.7	7.7		7.0	[CEB][ANOVA]
Copper	µg/g	6 / 6	6 / 6	100%	--	--	11	21	17	3.5	Normal	20	20		26	[bk]
Iron	µg/g	6 / 6	6 / 6	100%	--	--	15,000	65,000	47,167	17,691	Normal	61,720	61,720		52,000	[CEB][ANOVA]
Lead	µg/g	5 / 7	5 / 7	71%	10.0	10.0	15	201	53	72	Lognormal	1,025	201	#	14	[CEB][ANOVA]
Magnesium	µg/g	6 / 6	6 / 6	100%	--	--	290	989	613	292	Normal	853	853		1,399	[bk]
Manganese	µg/g	6 / 6	6 / 6	100%	--	--	85	740	410	240	Normal	608	608		682	[CEB][ANOVA]
Mercury	µg/g	2 / 6	2 / 6	33%	0.087	0.087	0.10	0.16	0.072	0.047	Lognormal	0.15	0.15		0.12	[CEB][ANOVA]
Nickel	µg/g	5 / 6	5 / 6	83%	7.5	7.5	10	19	12	5.2	Normal	16	16		21	[bk]
Potassium	µg/g	6 / 6	6 / 6	100%	--	--	417	892	610	189	Normal	765	765		1,324	[bk]
Sodium	µg/g	6 / 6	6 / 6	100%	--	--	62	360	125	116	Lognormal	291	291		--	[CEB]
Vanadium	µg/g	6 / 6	6 / 6	100%	--	--	55	89	72	11	Normal	81	81		96	[bk]
Zinc	µg/g	3 / 6	3 / 6	50%	39	94	71	100	58	35	Normal	87	87		71	[CEB][ANOVA]
Acetone	µg/g	3 / 6	3 / 6	50%	0.045	0.045	0.023	3.5	0.67	1.4	Lognormal	4,840	3.5	#	--	[CEB]
Benzo(a)anthracene	µg/g	2 / 6	2 / 6	33%	0.17	0.17	0.15	0.24	0.12	0.064	Lognormal	0.20	0.20		--	[CEB]
Heptachlor	µg/g	1 / 3	1 / 3	33%	0.0096	0.0096	0.092	0.092	--	--	Undetermined	--	0.092	#	--	[CEB]
Methylene Chloride	µg/g	1 / 6	1 / 6	17%	0.0062	0.0062	0.0065	0.0065	0.0037	0.0014	Lognormal	0.0050	0.0050		--	[CEB]
Phenanthrene	µg/g	1 / 6	1 / 6	17%	0.17	0.17	0.50	0.50	0.15	0.17	Lognormal	0.42	0.42		--	[CEB]
Toluene	µg/g	3 / 6	3 / 6	50%	0.0025	0.0025	0.0023	0.040	0.0084	0.016	Lognormal	0.20	0.040	#	--	[CEB]
Total Organic Carbon	µg/g	6 / 6	6 / 6	100%	--	--	1,340	12,200	5,705	4,721	Normal	9,589	9,589		--	[CEB]
bis(2-Ethylhexyl)phthalate	µg/g	1 / 6	1 / 6	17%	0.19	0.19	0.39	0.39	0.14	0.12	Lognormal	0.29	0.29		--	[CEB]

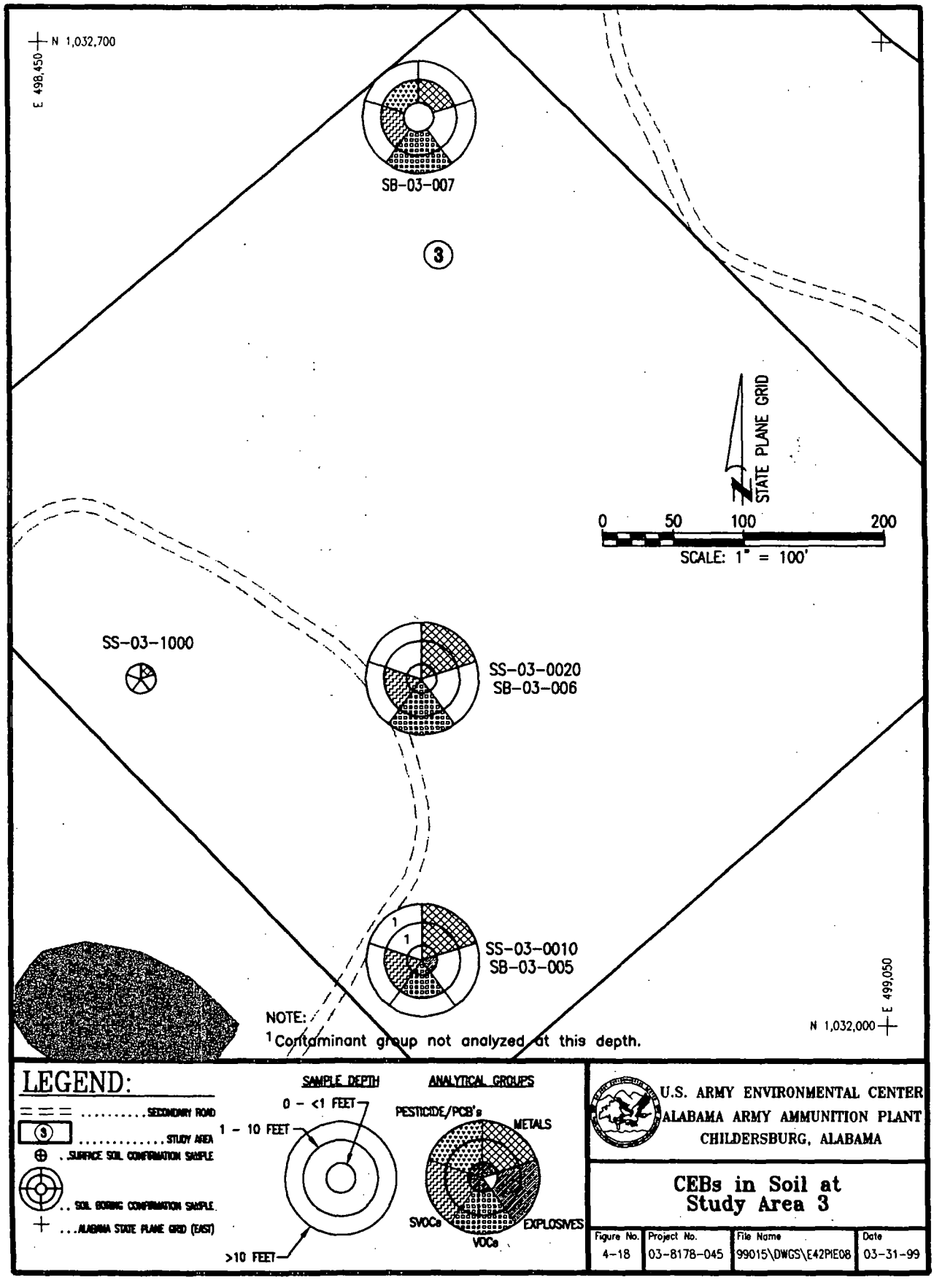
[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] *The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.*
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-21. Summary Statistics and Exposure Point Concentrations for Soil (>10 ft BLS) at Study Area 3 - Sanitary Landfill and Lead Facility
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:15:07 PM
Run Date: 3/29/99
Exposure Unit: 03_SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	3 / 3	3 / 3	100%	--	--	2,300	25,000	--	--	Undetermined	--	25,000	#	27,567	[bk]
Arsenic	µg/g	3 / 3	3 / 3	100%	--	--	16	41	--	--	Undetermined	--	41	#	52	[bk]
Barium	µg/g	3 / 3	3 / 3	100%	--	--	14	32	--	--	Undetermined	--	32	#	41	[bk]
Beryllium	µg/g	3 / 3	3 / 3	100%	--	--	0.57	1.2	--	--	Undetermined	--	1.2	#	0.89	[CEB]
Calcium	µg/g	2 / 3	2 / 3	67%	109	109	193	584	--	--	Undetermined	--	584	#	257	[CEB]
Chromium	µg/g	3 / 3	3 / 3	100%	--	--	7.7	42	--	--	Undetermined	--	42	#	53	[bk]
Cobalt	µg/g	2 / 3	2 / 3	67%	2.5	2.5	11	12	--	--	Undetermined	--	12	#	58	[bk]
Copper	µg/g	3 / 3	3 / 3	100%	--	--	17	25	--	--	Undetermined	--	25	#	56	[bk]
Iron	µg/g	3 / 3	3 / 3	100%	--	--	41,000	60,000	--	--	Undetermined	--	60,000	#	57,000	[CEB]
Lead	µg/g	7 / 7	7 / 7	100%	--	--	14	28	20	4.7	Normal	23	23		32	[bk]
Magnesium	µg/g	2 / 3	2 / 3	67%	138	138	233	742	--	--	Undetermined	--	742	#	867	[bk]
Manganese	µg/g	3 / 3	3 / 3	100%	--	--	161	710	--	--	Undetermined	--	710	#	1,331	[bk]
Nickel	µg/g	3 / 3	3 / 3	100%	--	--	14	25	--	--	Undetermined	--	25	#	46	[bk]
Potassium	µg/g	3 / 3	3 / 3	100%	--	--	260	1,010	--	--	Undetermined	--	1,010	#	1,206	[bk]
Sodium	µg/g	1 / 3	1 / 3	33%	50	50	70	70	--	--	Undetermined	--	70	#	--	[CEB]
Vanadium	µg/g	3 / 3	3 / 3	100%	--	--	28	82	--	--	Undetermined	--	82	#	92	[bk]
Zinc	µg/g	1 / 3	1 / 3	33%	34	61	65	65	--	--	Undetermined	--	65	#	104	[bk]
Acetone	µg/g	1 / 3	1 / 3	33%	0.026	0.031	0.024	0.024	--	--	Undetermined	--	0.024	#	--	[CEB]
Methylene Chloride	µg/g	2 / 3	2 / 3	67%	0.0062	0.0062	0.0047	0.0058	--	--	Undetermined	--	0.0058	#	--	[CEB]
Methylethylketone	µg/g	1 / 3	1 / 3	33%	0.0051	0.0051	0.022	0.022	--	--	Undetermined	--	0.022	#	--	[CEB]
Toluene	µg/g	1 / 3	1 / 3	33%	0.0025	0.0025	0.014	0.014	--	--	Undetermined	--	0.014	#	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)


N 1,032,700
E 498,450
SB-03-007
3
STATE PLANE GRID
0 50 100 200
SCALE: 1" = 100'
SS-03-1000
SS-03-0020
SB-03-006
SS-03-0010
SB-03-005
1
1
NOTE:
1 Contaminant group not analyzed at this depth.
N 1,032,000
E 499,050
LEGEND:
SECONDARY ROAD
STUDY AREA
SURFACE SOIL CONFIRMATION SAMPLE
SOIL BORING CONFIRMATION SAMPLE
ALABAMA STATE PLANE GRID (EAST)
SAMPLE DEPTH
0 - <1 FEET
1 - 10 FEET
>10 FEET
ANALYTICAL GROUPS
PESTICIDE/PCB's
METALS
SVOCs
EXPLOSIVES
VOCs
U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA
CEBs in Soil at
Study Area 3
Figure No. 4-18
Project No. 03-8178-045
File Name 99015\DWGS\E42PIE08
Date 03-31-99

Explosives—Explosives were not detected in any screening sample. Explosives were not detected in any surface or subsurface soil sample, except for 2,4-DNT in surface soil sample SS-03-0010 (see Sheet 4-8) at a concentration of 0.0953 µg/g.

VOCs—Four VOCs were detected in the Study Area 3 soils: acetone, toluene, methylene chloride, and MEK. The maximum concentrations of these VOCs detected in the soils are shown in the adjacent box. Acetone was detected in 5 of 12 samples, with only 2 samples exceeding the CRL. In these two samples, concentrations were 3.5 and 0.42 µg/g from the 1- and 10-foot intervals of boring SB-03-005, respectively. Results of acetone analyses for samples collected before June 19, 1995 (as was SS-03-0020), are believed to be suspect as a result of field laboratory activities. (Section 4.2 provides an additional explanation.) Toluene was detected in 5 of 12 samples, with the highest concentration of 0.04 µg/g in the 1-foot interval of boring SB-03-007. Toluene was not detected in this boring at greater depths. Methylene chloride was detected in 4 of 12 samples; all concentrations were near or below the CRL. MEK was detected in only one sample (SB-03-006 in the 20-foot interval) at 0.022 µg/g.

Maximum Concentrations			
Analyte (µg/g)	0-<1ft	1-10ft	>10ft
Acetone	0.026	3.5	0.024
Methylene Chloride	0.0081	0.0065	0.0058
MEK			0.022
Toluene	0.0062	0.04	0.014

SVOCs—Twelve SVOCs (11 of which are PAHs) were detected in soils from this study area, and are listed in the adjacent box. Most of the compounds were detected in the surface soils, with the exception of benzo(a)anthracene, B2EHP, and phenanthrene, which were detected in the shallow subsurface. B2EHP is a common laboratory contaminant.

All of the PAHs listed were detected in the sample collected at SS-03-0010 and nine of those listed were detected in SS-03-0020 in the southern and central portions of the study area, respectively. Concentrations of all detected PAHs were highest in SS-03-0010. Concentrations in SS-03-0010 ranged from 0.15 µg/g for anthracene to 1.6 µg/g for fluoranthene.

Maximum Concentrations			
Analyte (µg/g)	0-<1ft	1-10ft	>10ft
Anthracene	0.15		
Benzo(a)anthracene	0.73	0.24	
Benzo(a)pyrene	0.73		
Benzo(b)fluoranthene	0.94		
Benzo(g,h,i)perylene	0.34		
Benzo(k)fluoranthene	0.41		
B2EHP		0.39	
Chrysene	0.81		
Fluoranthene	1.6		
Indeno(1,2,3-cd)pyrene	0.35		
Phenanthrene	0.72	0.5	
Pyrene	1.2		

Pesticides/PCBs—Heptachlor was the only pesticide detected in the soils at Study Area 3. Heptachlor was detected in only one subsurface sample (SB-03-007) at the 1-foot interval at 0.0919 µg/g. Heptachlor was not detected in a duplicate of this sample or in deeper samples collected at this location.

Summary—Metals and PAHs are present in the surface soils at Study Area 3. These results are consistent with the use of this area as a burning ground. Concentrations of metals and PAHs

generally decreased with depth in the soil. VOCs were detected in the surface and subsurface soils and may be due to the shallow burial of material. The explosive compound 2,4-DNT was detected in only one sample at the study area. The pesticide (heptachlor) also was detected in one location at this study area.

In conclusion, various types of chemicals were detected in the soils at Study Area 3 at concentrations exceeding background. These included metals, VOCs, SVOCs, one explosive compound, and one pesticide. Contamination is distributed primarily in the surface soils and to a lesser extent in the subsurface soils. The data are consistent with the use of the area as a burning and solid waste disposal area.

4.5.5 Study Area 4 – Manhattan Project Area

Study Area 4, the Manhattan Project Area, was used by the Atomic Energy Commission (now the Department of Energy) from 1943 to 1945. It is believed that heavy water (deuterium oxide) was produced. Neither records nor personnel interviews indicated that radiological waste ever had been buried at the site. The entire project facility has been destroyed except for one small building (DA 1978). Concentrations of lead were detected in two soil samples collected during a previous environmental survey (ESE 1981).

Four surface soil samples and 17 subsurface soil samples from 3 borings were collected during Phase 1 of the Supplemental RI and screened for lead on a quick-turnaround basis at the offsite laboratory. In addition, two surface soil and eight subsurface soil samples were collected and analyzed for metals, explosives, VOCs, and SVOCs. Two additional surface soil samples were analyzed for metals (excluding mercury) only. During Phase 2, two additional surface soil samples were collected from location SS-04-0000 and analyzed for aluminum and lead.

The data summary tables for Study Area 4 are presented in Appendix K. **Tables 4-22** through **4-24** present summary statistics for the soils collected at Study Area 4. **Figure 4-19** shows the locations where the general contaminant group CEBs (metals, SVOCs, VOCs, and explosives) were detected at Study Area 4. The lack of quadrants in a circle indicates that a sample was not collected at that interval. Sheets 4-5 and 4-6 present the screening results for surface and subsurface soils, respectively, for Study Area 4.

Metals—Thirteen metals were detected in Study Area 4 soils at concentrations that exceeded background. They are listed in the adjacent box, along with the maximum concentration detected.

	Maximum Concentrations*		
Analyte (µg/g)	0-<1ft	1-10ft	>10ft
Aluminum	40,000		
Beryllium	5.17		1.16
Barium	245	**77.3**	53.8
Calcium	100,000	2,520	347
Cobalt		**8.07**	
Copper	**20**		
Lead	**1,800**	2,200	92.8
Magnesium	23,000		
Mercury	**0.169**	**2.3**	
Nickel	**16.6**		
Potassium	4,170		
Sodium	808		**397**
Zinc	**237**		

* Metals also determined to exceed background based on ANOVA evaluation are shown in bold.

Table 4-22. Summary Statistics and Exposure Point Concentrations for Soil (0-<1 ft BLS) at Study Area 4 - Manhattan Project Area
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:17:38 PM
Run Date: 3/29/99
Exposure Unit: 04__SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	6 / 6	4 / 4	100%	--	--	14,600	40,000	21,683	5,325	Normal	27,949	27,949		20,277	[CEB][ANOVA]
Barium	µg/g	4 / 4	4 / 4	100%	--	--	102	245	159	61	Normal	231	231		124	[CEB][ANOVA]
Beryllium	µg/g	4 / 4	4 / 4	100%	--	--	0.94	5.2	2.3	1.9	Normal	4.6	4.6		0.82	[CEB][ANOVA]
Calcium	µg/g	4 / 4	4 / 4	100%	--	--	6,700	100,000	34,425	43,960	Lognormal	6.23E+06	100,000	#	4,960	[CEB][ANOVA]
Chromium	µg/g	4 / 4	4 / 4	100%	--	--	30	36	33	2.4	Normal	35	35		54	[bk]
Cobalt	µg/g	3 / 4	3 / 4	75%	2.5	2.5	5.2	9.1	5.5	3.3	Normal	9.3	9.1	#	14	[bk]
Copper	µg/g	4 / 4	4 / 4	100%	--	--	12	20	15	3.7	Normal	19	19		13	[CEB]
Iron	µg/g	4 / 4	4 / 4	100%	--	--	23,000	30,000	26,250	2,986	Normal	29,764	29,764		37,560	[bk]
Lead	µg/g	6 / 6	4 / 4	100%	--	--	12	1,800	477	882	Lognormal	1.99E+10	1,800	#	34	[CEB]
Magnesium	µg/g	4 / 4	4 / 4	100%	--	--	1,240	23,000	7,533	10,343	Lognormal	3.08E+06	23,000	#	1,189	[CEB][ANOVA]
Manganese	µg/g	4 / 4	4 / 4	100%	--	--	440	1,300	695	406	Lognormal	2,016	1,300	#	1,730	[bk]
Mercury	µg/g	2 / 2	2 / 2	100%	--	--	0.14	0.17	--	--	Undetermined	--	0.17	#	0.056	[CEB]
Nickel	µg/g	4 / 4	4 / 4	100%	--	--	9.9	17	13	3.1	Normal	16	16		9.4	[CEB]
Potassium	µg/g	4 / 4	4 / 4	100%	--	--	1,070	4,170	2,038	1,435	Lognormal	8,896	4,170	#	680	[CEB][ANOVA]
Sodium	µg/g	4 / 4	4 / 4	100%	--	--	120	808	300	339	Lognormal	8,148	808	#	501	[CEB][ANOVA]
Vanadium	µg/g	4 / 4	4 / 4	100%	--	--	37	63	49	11	Normal	61	61		76	[bk]
Zinc	µg/g	4 / 4	4 / 4	100%	--	--	50	237	108	88	Normal	212	212		36	[CEB]
Benzo(a)anthracene	µg/g	1 / 2	1 / 2	50%	0.17	0.17	1.2	1.2	--	--	Undetermined	--	1.2	#	--	[CEB]
Benzo(a)pyrene	µg/g	1 / 2	1 / 2	50%	0.24	0.24	1.3	1.3	--	--	Undetermined	--	1.3	#	--	[CEB]
Benzo(b)fluoranthene	µg/g	1 / 2	1 / 2	50%	0.73	0.73	2.4	2.4	--	--	Undetermined	--	2.4	#	--	[CEB]
Benzo(g,h,i)perylene	µg/g	1 / 2	1 / 2	50%	0.25	0.25	0.93	0.93	--	--	Undetermined	--	0.93	#	--	[CEB]
Benzo(k)fluoranthene	µg/g	1 / 2	1 / 2	50%	0.40	0.40	1.3	1.3	--	--	Undetermined	--	1.3	#	--	[CEB]
Chrysene	µg/g	1 / 2	1 / 2	50%	0.27	0.27	1.3	1.3	--	--	Undetermined	--	1.3	#	--	[CEB]
Fluoranthene	µg/g	1 / 2	1 / 2	50%	0.17	0.17	4.4	4.4	--	--	Undetermined	--	4.4	#	--	[CEB]
Indeno(1,2,3-cd)pyrene	µg/g	1 / 2	1 / 2	50%	0.17	0.17	0.84	0.84	--	--	Undetermined	--	0.84	#	--	[CEB]
Phenanthrene	µg/g	1 / 2	1 / 2	50%	0.17	0.17	1.2	1.2	--	--	Undetermined	--	1.2	#	--	[CEB]
Pyrene	µg/g	1 / 2	1 / 2	50%	0.97	0.97	2.1	2.1	--	--	Undetermined	--	2.1	#	--	[CEB]
Total Organic Carbon	µg/g	2 / 2	2 / 2	100%	--	--	38,000	96,800	--	--	Undetermined	--	96,800	#	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-23. Summary Statistics and Exposure Point Concentrations for Soil (1-10 ft BLS) at Study Area 4 - Manhattan Project Area
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:17:38 PM
Run Date: 3/29/99
Exposure Unit: 04_SSI

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	2 / 2	2 / 2	100%	--	--	3,900	19,000	--	--	Undetermined	--	19,000	#	27,733	[bk]
Barium	µg/g	2 / 2	2 / 2	100%	--	--	42	77	--	--	Undetermined	--	77	#	64	[CEB]
Beryllium	µg/g	2 / 2	2 / 2	100%	--	--	0.38	0.55	--	--	Undetermined	--	0.55	#	0.80	[bk]
Calcium	µg/g	2 / 2	2 / 2	100%	--	--	1,520	2,520	--	--	Undetermined	--	2,520	#	2,475	[CEB]
Chromium	µg/g	2 / 2	2 / 2	100%	--	--	23	43	--	--	Undetermined	--	43	#	46	[bk]
Cobalt	µg/g	2 / 2	2 / 2	100%	--	--	4.3	8.1	--	--	Undetermined	--	8.1	#	7.0	[CEB]
Copper	µg/g	1 / 2	1 / 2	50%	3.4	3.4	6.2	6.2	--	--	Undetermined	--	6.2	#	26	[bk]
Iron	µg/g	2 / 2	2 / 2	100%	--	--	10,000	23,000	--	--	Undetermined	--	23,000	#	52,000	[bk]
Lead	µg/g	5 / 9	5 / 9	56%	10.0	10.0	13	2,200	274	725	Lognormal	20,476	2,200	#	14	[CEB][ANOVA]
Magnesium	µg/g	2 / 2	2 / 2	100%	--	--	383	962	--	--	Undetermined	--	962	#	1,399	[bk]
Manganese	µg/g	2 / 2	2 / 2	100%	--	--	170	500	--	--	Undetermined	--	500	#	682	[bk]
Mercury	µg/g	1 / 3	1 / 3	33%	0.087	0.087	2.3	2.3	--	--	Undetermined	--	2.3	#	0.12	[CEB]
Potassium	µg/g	2 / 2	2 / 2	100%	--	--	186	537	--	--	Undetermined	--	537	#	1,324	[bk]
Vanadium	µg/g	2 / 2	2 / 2	100%	--	--	35	38	--	--	Undetermined	--	38	#	96	[bk]
Acetone	µg/g	2 / 3	2 / 3	67%	0.045	0.045	0.037	2.5	--	--	Undetermined	--	2.5	#	--	[CEB]
Anthracene	µg/g	1 / 3	1 / 3	33%	0.17	0.17	0.11	0.11	--	--	Undetermined	--	0.11	#	--	[CEB]
Benzo(a)anthracene	µg/g	1 / 3	1 / 3	33%	0.17	0.17	0.34	0.34	--	--	Undetermined	--	0.34	#	--	[CEB]
Benzo(a)pyrene	µg/g	1 / 3	1 / 3	33%	0.24	0.24	0.35	0.35	--	--	Undetermined	--	0.35	#	--	[CEB]
Benzo(b)fluoranthene	µg/g	1 / 3	1 / 3	33%	0.73	0.73	0.94	0.94	--	--	Undetermined	--	0.94	#	--	[CEB]
Chrysene	µg/g	1 / 3	1 / 3	33%	0.27	0.27	0.37	0.37	--	--	Undetermined	--	0.37	#	--	[CEB]
Fluoranthene	µg/g	1 / 3	1 / 3	33%	0.17	0.17	0.65	0.65	--	--	Undetermined	--	0.65	#	--	[CEB]
Phenanthrene	µg/g	1 / 3	1 / 3	33%	0.17	0.17	0.31	0.31	--	--	Undetermined	--	0.31	#	--	[CEB]
Toluene	µg/g	2 / 3	2 / 3	67%	0.0025	0.0025	0.0082	0.013	--	--	Undetermined	--	0.013	#	--	[CEB]
Total Organic Carbon	µg/g	3 / 3	3 / 3	100%	--	--	7,500	15,900	--	--	Undetermined	--	15,900	#	--	[CEB]

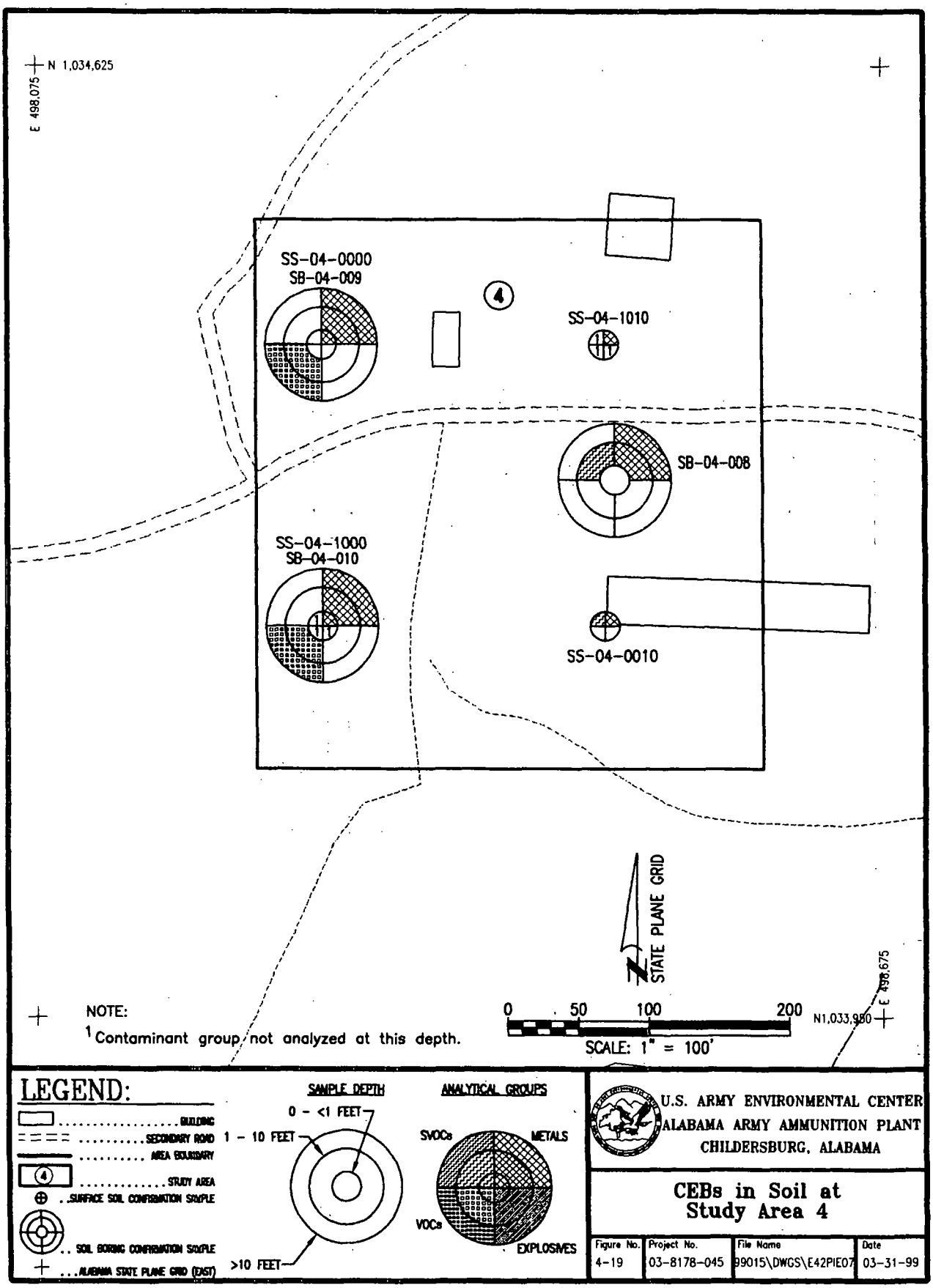
[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-24. Summary Statistics and Exposure Point Concentrations for Soil (>10 ft BLS) at Study Area 4 - Manhattan Project Area
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:17:38 PM
Run Date: 3/29/99
Exposure Unit: 04__SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	4 / 4	4 / 4	100%	--	--	4,230	22,000	14,558	7,836	Normal	23,778	22,000	#	27,567	{bk}
Barium	µg/g	4 / 4	4 / 4	100%	--	--	18	54	31	16	Normal	50	50		41	{CEB}{ANOVA}
Beryllium	µg/g	4 / 4	4 / 4	100%	--	--	0.74	1.2	0.91	0.18	Normal	1.1	1.1		0.89	{CEB}{ANOVA}
Calcium	µg/g	3 / 4	3 / 4	75%	109	109	157	347	189	121	Normal	331	331		257	{CEB}{ANOVA}
Chromium	µg/g	4 / 4	4 / 4	100%	--	--	13	39	23	11	Normal	36	36		53	{bk}
Cobalt	µg/g	4 / 4	4 / 4	100%	--	--	4.8	6.8	6.1	0.89	Normal	7.1	6.8	#	58	{bk}
Copper	µg/g	4 / 4	4 / 4	100%	--	--	9.2	26	18	7.2	Normal	26	26	#	56	{bk}
Iron	µg/g	4 / 4	4 / 4	100%	--	--	12,000	49,000	33,250	17,858	Normal	54,263	49,000	#	57,000	{bk}
Lead	µg/g	7 / 8	7 / 8	88%	10.0	10.0	16	93	34	27	Lognormal	104	93	#	32	{CEB}{ANOVA}
Magnesium	µg/g	4 / 4	4 / 4	100%	--	--	271	614	454	151	Normal	632	614	#	867	{bk}
Manganese	µg/g	4 / 4	4 / 4	100%	--	--	97	700	281	283	Normal	615	615		1,331	{bk}
Nickel	µg/g	3 / 4	3 / 4	75%	7.5	7.5	13	14	11	5.0	Lognormal	66	14	#	46	{bk}
Potassium	µg/g	4 / 4	4 / 4	100%	--	--	351	825	589	219	Normal	846	825	#	1,206	{bk}
Sodium	µg/g	2 / 4	2 / 4	50%	50	50	202	397	162	177	Normal	371	371		--	{CEB}
Vanadium	µg/g	4 / 4	4 / 4	100%	--	--	13	78	43	27	Normal	75	75		92	{bk}
Zinc	µg/g	2 / 4	2 / 4	50%	33	98	60	81	52	27	Normal	83	81	#	104	{bk}
Acetone	µg/g	4 / 5	4 / 5	80%	0.045	0.045	0.024	0.092	0.049	0.030	Normal	0.077	0.077		--	{CEB}
Methylene Chloride	µg/g	1 / 5	1 / 5	20%	0.0062	0.0062	0.0046	0.0046	0.0034	0.00067	Lognormal	0.0041	0.0041		--	{CEB}
Toluene	µg/g	2 / 5	2 / 5	40%	0.0025	0.0025	0.0026	0.013	0.0039	0.0051	Lognormal	0.049	0.013	#	--	{CEB}
Total Organic Carbon	µg/g	1 / 5	1 / 5	20%	1000	1000	3,290	3,290	1,058	1,248	Lognormal	6,199	3,290	#	--	{CEB}

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)


N 1,034,625
E 498,075
SS-04-0000
SB-04-009
4
SS-04-1010
SB-04-008
SS-04-1000
SB-04-010
SS-04-0010
STATE PLANE GRID
0 50 100 200
SCALE: 1" = 100'
N1,033,950
E 498,675
NOTE:
1 Contaminant group not analyzed at this depth.
LEGEND:
BUILDING
SECONDARY ROAD
AREA BOUNDARY
STUDY AREA
SURFACE SOIL CONFIRMATION SAMPLE
SOIL BORING CONFIRMATION SAMPLE
ALABAMA STATE PLANE GRID (EAST)
SAMPLE DEPTH
0 - <1 FEET
1 - 10 FEET
>10 FEET
ANALYTICAL GROUPS
SVOCs
METALS
VOCs
EXPLOSIVES
U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA
CEBs in Soil at
Study Area 4
Figure No. 4-19
Project No. 03-8178-045
File Name 99015\DWGS\E42PIE07
Date 03-31-99

The maximum concentrations of copper, lead, mercury, nickel, and zinc in surface soils were detected at location SS-04-0010. The maximum concentrations of barium and cobalt in shallow subsurface soils were detected at location SB-04-009. The maximum concentrations of lead and mercury in the shallow subsurface soils were detected at SB-04-008. The highest detected concentration of mercury at the study area was in the 1-foot interval at location SB-04-008. The maximum detected concentrations of lead in surface and shallow subsurface soils were 1,800 µg/g (SS-04-0010) and 2,200 µg/g (SB-04-008, 1 foot BLS), respectively. All other lead concentrations in the Study Area 4 soils were one to two orders of magnitude lower. Because of the lack of information on the study area, it is not known whether it contains a source for these metals.

Explosives—Explosives were not detected in any surface or subsurface soil samples.

VOCs—Three VOCs were detected in the subsurface soils at Study Area 4. The maximum concentrations detected are shown in the adjacent box. Acetone was detected in six of eight subsurface soil samples, with concentrations above the CRL detected in three of the samples. Methylene chloride was detected only at location SB-04-010 in the 25-foot interval. Toluene was detected in four of the eight soil subsurface samples; the highest concentration was detected in boring SB-04-010 at the 1- and 15-foot intervals.

Maximum Concentrations			
Analyte (µg/g)	0-<1ft	1-10ft	>10ft
Acetone		2.5	0.092
Methylene Chloride			0.0046
Toluene		0.013	0.013

SVOCs—Eleven PAHs were detected in surface soil sample SS-04-0010, at concentrations ranging from 0.84 µg/g for indeno(1,2,3-cd)-pyrene to 4.4 µg/g for fluoranthene. Seven PAHs were detected in the 1-foot interval sample at location SB-04-008. Concentrations ranged from 0.11 µg/g for anthracene to 0.94 µg/g for benzo(b)fluoranthene. SVOCs were not detected in any deep subsurface soil samples. The detected PAH concentrations are listed in the adjacent box.

Maximum Concentrations			
Analyte (µg/g)	0-<1ft	1-10ft	>10ft
Anthracene		0.11	
Benzo(a)anthracene	1.2	0.34	
Benzo(a)pyrene	1.3	0.35	
Benzo(b)fluoranthene	2.4	0.94	
Benzo(g,h,i)perylene	0.93		
Benzo(k)fluoranthene	1.3		
Chrysene	1.3	0.37	
Fluoranthene	4.4	0.65	
Indeno(1,2,3-cd)pyrene	0.84		
Phenanthrene	1.2	0.31	
Pyrene	2.1		

Summary—Little information is available concerning the historical use of this study area. It is believed that heavy water (deuterium oxide) was produced. The entire project facility was destroyed except for one small building. A variety of metals, 11 PAHs, and 3 VOCs were detected in the soils at Study Area 4. Thirteen metals were identified as CEBs, the most notable of which was lead. Lead was detected at maximum concentrations of 1,800 and 2,200 µg/g in surface and shallow subsurface soils, respectively. PAHs were not detected in samples collected from depths greater than 1 foot BLS. The presence of PAHs may be related to burning of the buildings; metals may have been used in the deuterium process. Methylene chloride and toluene were detected at low

(<0.1 µg/g) concentrations at various locations throughout the subsurface soils. Acetone was detected in six samples at concentrations ≤2.5 µg/g.

4.5.6 Study Area 6 – Southern TNT Manufacturing Area

Study Area 6 was the Southern TNT Manufacturing Area where TNT was produced along four production lines. Soil samples collected during previous investigation activities were contaminated with TNT, 2,4-DNT, and 2,6-DNT (ESE 1993).

The area was sampled by Roy F. Weston on 50-foot grids and samples were field screened for explosives. Samples also were analyzed for lead. A screening criteria of 647 µg/g TNT was used as the guideline for remediation. Based on the Roy F. Weston investigation, portions of the study area that contained explosives concentrations exceeding 647 µg/g were remediated to levels of 100 µg/g of TNT. **Figure 4-20** shows the areas of contaminated soils that have been excavated and remediated at Study Area 6. A total of 27,703 cubic yards of explosives-contaminated soils were excavated from the area (Weston 1996). Following remediation, confirmatory samples were collected just below the excavation depth to verify that remediation was adequate.

As a followup to the remediation activities conducted by Roy F. Weston, five soil borings were placed adjacent to excavated areas during Phase 1 of the Supplemental RI. Six samples from each of the five borings were screened for explosives in the field, beginning with the surface and proceeding from 1 to 30 feet at 5-foot intervals. Two samples (1- and 25-foot intervals) from each boring were sent to the laboratory for analysis of metals, explosives, VOCs, and SVOCs. One additional 1-foot BLS soil sample from location SB-06-011 was sent to the laboratory for VOC analysis. Two of the samples were analyzed for hexavalent chromium.

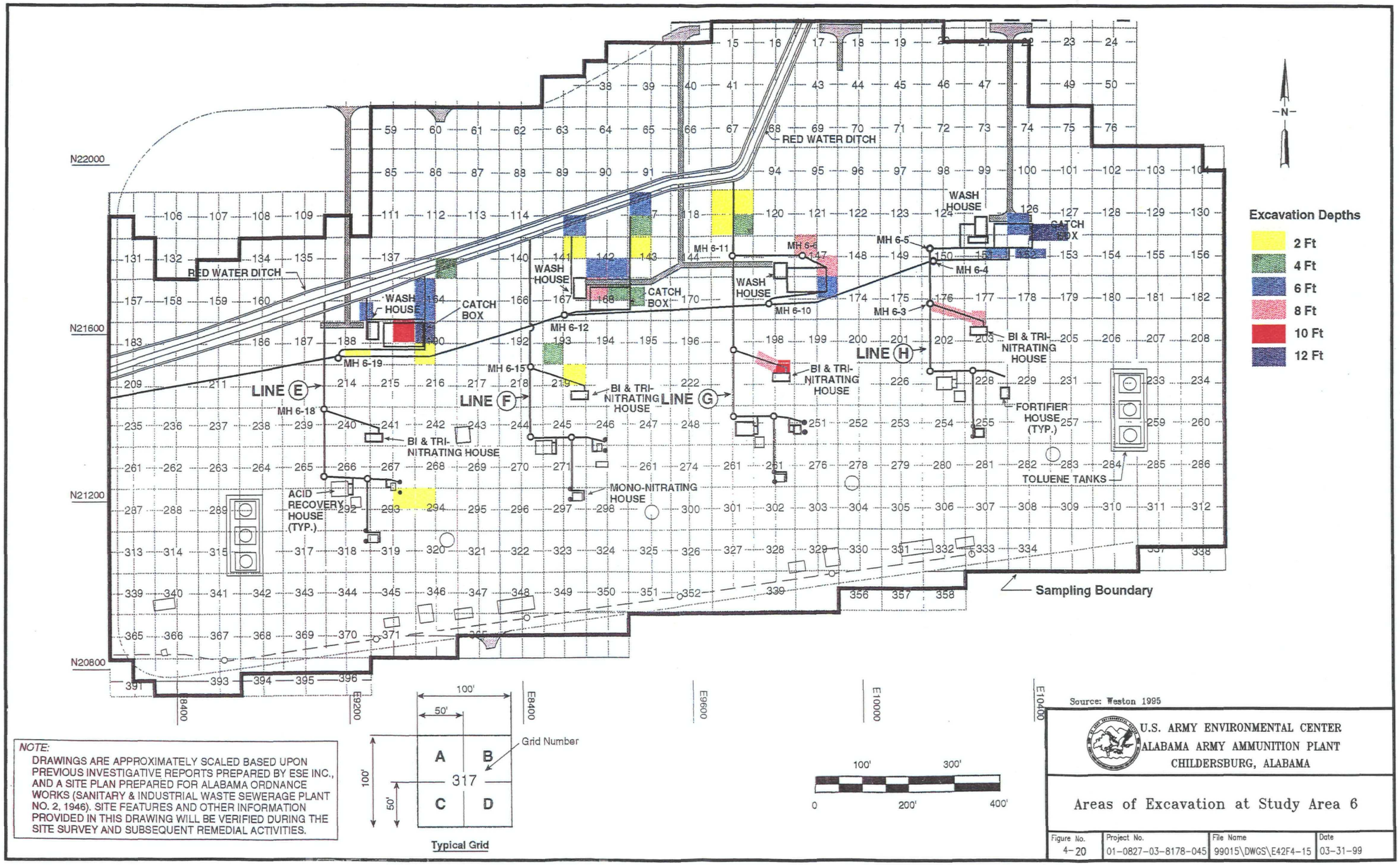
The data summary tables for Study Area 6 are presented in Appendices K (SAIC) and L (Roy F. Weston). The Roy F. Weston data were combined with the data collected by SAIC during the Supplemental RI for evaluation. **Tables 4-25** through **4-27** present summary statistics for the soil samples collected from Study Area 6. **Figure 4-21** shows the locations where the general contaminant group CEBs (metals, SVOCs, VOCs, and explosives) were detected in Supplemental RI samples collected at Study Area 6. The lack of quadrants in a circle indicates that a soil sample was not collected at that interval.

Maximum Concentrations*			
Analyte (µg/g)	0-<1ft	1-10ft	>10ft
Barium			133
Beryllium			2.28
Calcium			711
Cobalt		10.8	
Iron			67,000
Lead**	142	**380**	72
Magnesium		1,600	1,840
Potassium		3,000	3,730
Selenium			**27.1**
Sodium			**94**

* Metals also determined to exceed background based on ANOVA evaluation are shown in bold.

** Roy F. Weston data.

Metals—Lead was detected in all 298 surface soil samples collected, at concentrations ≤142 µg/g (see adjacent box). Lead was the only metal analyzed for by Roy F. Weston. Lead was detected at maximum concentrations of 380 and



NOTE:
DRAWINGS ARE APPROXIMATELY SCALED BASED UPON PREVIOUS INVESTIGATIVE REPORTS PREPARED BY ESE INC., AND A SITE PLAN PREPARED FOR ALABAMA ORDNANCE WORKS (SANITARY & INDUSTRIAL WASTE SEWERAGE PLANT NO. 2, 1946). SITE FEATURES AND OTHER INFORMATION PROVIDED IN THIS DRAWING WILL BE VERIFIED DURING THE SITE SURVEY AND SUBSEQUENT REMEDIAL ACTIVITIES.

Source: Weston 1995

U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

Areas of Excavation at Study Area 6

Figure No.	Project No.	File Name	Date
4-20	01-0827-03-8178-045	99015\DWGS\E42F4-15	03-31-99

Table 4-25. Summary Statistics and Exposure Point Concentrations for Soil (0-<1 ft BLS) at Study Area 6 - Southern TNT Manufacturing Area
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:23:06 PM
Run Date: 3/29/99
Exposure Unit: 06__SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]	2 x BK Mean[g]	Background Comparison[g]
Lead	µg/g	298 / 298	298 / 298	100%	--	--	1.3	142	11	15	Lognormal	11	11	34	[CEB][ANOVA]
1,3,5-Trinitrobenzene	µg/g	1 / 298	1 / 298	0%	0.50	0.50	0.99	0.99	0.25	0.043	Lognormal	0.32	0.32	--	[CEB]
2,4,6-Trinitrotoluene	µg/g	6 / 298	6 / 298	2%	0.50	0.50	0.70	11	0.31	0.63	Lognormal	0.28	0.28	--	[CEB]
2,6-Dinitrotoluene	µg/g	1 / 298	1 / 298	0%	0.50	0.50	1.00	1.00	0.25	0.043	Lognormal	0.32	0.32	--	[CEB]
2-Amino-4,6-Dinitrotoluene	µg/g	2 / 298	2 / 298	1%	0.50	0.50	1.4	5.3	0.27	0.30	Lognormal	0.26	0.26	--	[CEB]
Nitrobenzene	µg/g	1 / 298	1 / 298	0%	0.50	0.50	0.70	0.70	0.25	0.026	Lognormal	0.36	0.36	--	[CEB]
Tetryl	µg/g	1 / 298	1 / 298	0%	0.50	0.50	0.70	0.70	0.25	0.026	Lognormal	0.36	0.36	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB *(chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean;* bk *(background) - the maximum detected result is less than two times the background mean;* ANOVA - *analysis of variance* determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-26. Summary Statistics and Exposure Point Concentrations for Soil (1-10 ft BLS) at Study Area 6 - Southern TNT Manufacturing Area
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:23:06 PM
Run Date: 3/29/99
Exposure Unit: 06_SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	5 / 5	5 / 5	100%	--	--	8,300	23,000	14,000	5,991	Normal	19,712	19,712		27,733	[bk]
Arsenic	µg/g	1 / 5	1 / 5	20%	13	13	25	25	10	8.4	Lognormal	28	25	#	42	[bk]
Barium	µg/g	5 / 5	5 / 5	100%	--	--	12	62	42	20	Normal	61	61		64	[bk]
Beryllium	µg/g	3 / 5	3 / 5	60%	0.25	0.25	0.42	0.78	0.39	0.28	Normal	0.65	0.65		0.80	[bk]
Calcium	µg/g	5 / 5	5 / 5	100%	--	--	242	934	556	278	Normal	821	821		2,475	[bk]
Chromium	µg/g	4 / 5	4 / 5	80%	30	30	17	34	22	8.2	Normal	30	30		46	[bk]
Cobalt	µg/g	2 / 5	2 / 5	40%	2.5	2.5	11	11	5.1	5.2	Lognormal	169	11	#	7.0	[CEB][ANOVA]
Copper	µg/g	2 / 5	2 / 5	40%	3.4	12	11	14	6.8	5.5	Normal	12	12		26	[bk]
Iron	µg/g	5 / 5	5 / 5	100%	--	--	18,000	34,000	28,400	6,348	Normal	34,452	34,000	#	52,000	[bk]
Lead	µg/g	38 / 41	38 / 41	93%	10.0	10.0	4.8	380	27	62	Lognormal	28	28		14	[CEB]
Magnesium	µg/g	5 / 5	5 / 5	100%	--	--	175	1,600	943	608	Normal	1,523	1,523		1,399	[CEB][ANOVA]
Manganese	µg/g	5 / 5	5 / 5	100%	--	--	31	390	184	150	Normal	327	327		682	[bk]
Nickel	µg/g	3 / 5	3 / 5	60%	7.5	7.5	9.7	12	8.3	4.3	Normal	12	12	#	21	[bk]
Potassium	µg/g	5 / 5	5 / 5	100%	--	--	285	3,000	1,724	1,136	Normal	2,807	2,807		1,324	[CEB][ANOVA]
Vanadium	µg/g	5 / 5	5 / 5	100%	--	--	25	76	43	21	Normal	63	63		96	[bk]
Zinc	µg/g	1 / 5	1 / 5	20%	14	29	46	46	17	17	Lognormal	82	46	#	71	[bk]
2,4,6-Trinitrotoluene	µg/g	25 / 40	25 / 40	63%	0.089	0.50	0.17	36	4.8	8.9	Lognormal	15	15		--	[CEB]
Acetone	µg/g	2 / 6	2 / 6	33%	0.045	0.045	0.76	1.6	0.41	0.65	Lognormal	794	1.6	#	--	[CEB]
Benzo(a)anthracene	µg/g	1 / 5	1 / 5	20%	0.17	0.17	0.47	0.47	0.16	0.17	Lognormal	0.72	0.47	#	--	[CEB]
Benzo(a)pyrene	µg/g	1 / 5	1 / 5	20%	0.24	0.24	0.52	0.52	0.20	0.18	Lognormal	0.63	0.52	#	--	[CEB]
Benzo(b)fluoranthene	µg/g	1 / 5	1 / 5	20%	0.73	0.73	1.4	1.4	0.57	0.46	Lognormal	1.5	1.4	#	--	[CEB]
Benzo(g,h,i)perylene	µg/g	1 / 5	1 / 5	20%	0.25	0.25	0.27	0.27	0.15	0.065	Lognormal	0.24	0.24		--	[CEB]
Benzo(k)fluoranthene	µg/g	1 / 5	1 / 5	20%	0.40	0.40	0.56	0.56	0.27	0.16	Lognormal	0.52	0.52		--	[CEB]
Chrysene	µg/g	1 / 5	1 / 5	20%	0.27	0.27	0.77	0.77	0.26	0.28	Lognormal	1.2	0.77	#	--	[CEB]
Fluoranthene	µg/g	1 / 5	1 / 5	20%	0.17	0.17	0.98	0.98	0.26	0.40	Lognormal	4.6	0.98	#	--	[CEB]
Indeno(1,2,3-cd)pyrene	µg/g	1 / 5	1 / 5	20%	0.17	0.17	0.31	0.31	0.13	0.10	Lognormal	0.33	0.31	#	--	[CEB]
Pyrene	µg/g	1 / 5	1 / 5	20%	0.97	0.97	1.1	1.1	0.61	0.28	Lognormal	0.98	0.98		--	[CEB]
Tetryl	µg/g	2 / 40	2 / 40	5%	0.093	0.69	0.70	2.7	0.30	0.40	Lognormal	0.37	0.37		--	[CEB]
Toluene	µg/g	3 / 6	3 / 6	50%	0.0025	0.0025	0.0023	0.026	0.0059	0.0099	Lognormal	0.068	0.026	#	--	[CEB]
Total Organic Carbon	µg/g	3 / 5	3 / 5	60%	1000	1000	6,080	11,200	4,984	4,550	Normal	9,322	9,322		--	[CEB]

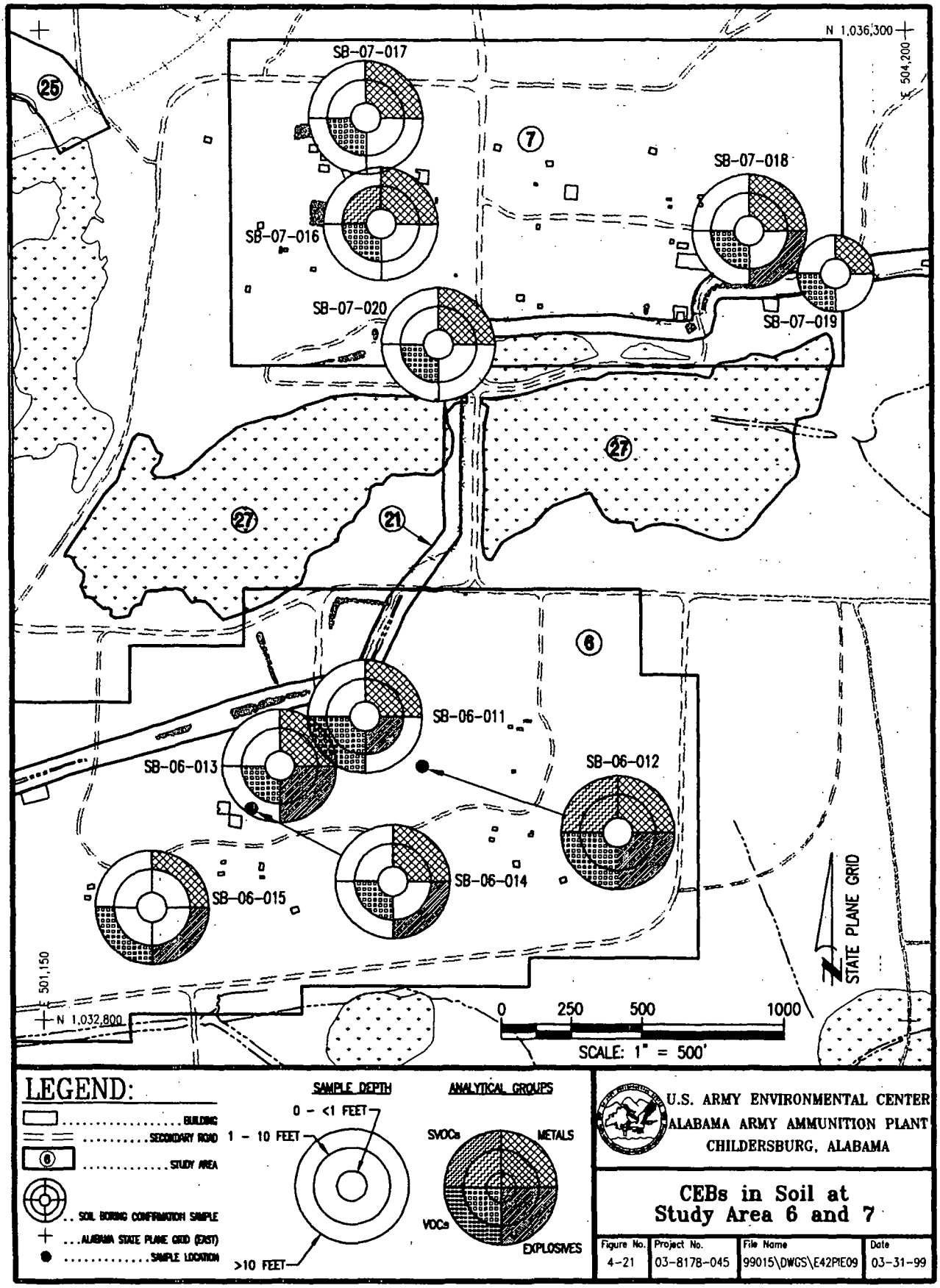
[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-27. Summary Statistics and Exposure Point Concentrations for Soil (>10 ft BLS) at Study Area 6 - Southern TNT Manufacturing Area
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:23:06 PM
Run Date: 3/29/99
Exposure Unit: 06__SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	5 / 5	5 / 5	100%	--	--	5,880	20,000	12,176	6,751	Normal	18,613	18,613		27,567	[bk]
Barium	µg/g	5 / 5	5 / 5	100%	--	--	17	133	53	47	Normal	98	98		41	[CEB][ANOVA]
Beryllium	µg/g	4 / 5	4 / 5	80%	0.25	0.25	0.46	2.3	1.2	1.0	Normal	2.2	2.2		0.89	[CEB][ANOVA]
Calcium	µg/g	2 / 5	2 / 5	40%	109	109	322	711	239	288	Lognormal	9,978	711	#	257	[CEB][ANOVA]
Chromium	µg/g	5 / 5	5 / 5	100%	--	--	11	23	16	5.5	Normal	21	21		53	[bk]
Cobalt	µg/g	4 / 5	4 / 5	80%	2.5	2.5	7.0	18	8.4	5.9	Normal	14	14		58	[bk]
Copper	µg/g	4 / 5	4 / 5	80%	6.8	6.8	11	33	17	11	Normal	27	27		56	[bk]
Iron	µg/g	5 / 5	5 / 5	100%	--	--	12,000	67,000	33,200	21,253	Normal	53,463	53,463		57,000	[CEB][ANOVA]
Lead	µg/g	3 / 7	3 / 7	43%	10.0	10.0	6.9	72	20	26	Lognormal	141	72	#	32	[CEB][ANOVA]
Magnesium	µg/g	5 / 5	5 / 5	100%	--	--	320	1,840	1,094	669	Normal	1,732	1,732		867	[CEB][ANOVA]
Manganese	µg/g	5 / 5	5 / 5	100%	--	--	32	570	259	272	Normal	518	518		1,331	[bk]
Mercury	µg/g	1 / 5	1 / 5	20%	0.087	0.087	0.16	0.16	0.068	0.054	Lognormal	0.18	0.16	#	0.36	[bk]
Nickel	µg/g	3 / 5	3 / 5	60%	7.5	7.5	11	42	17	16	Normal	33	33		46	[bk]
Potassium	µg/g	5 / 5	5 / 5	100%	--	--	637	3,730	2,047	1,415	Normal	3,396	3,396		1,206	[CEB][ANOVA]
Selenium	µg/g	1 / 5	1 / 5	20%	12	12	27	27	10	9.3	Lognormal	33	27	#	--	[CEB]
Sodium	µg/g	2 / 5	2 / 5	40%	50	50	77	94	49	34	Normal	81	81		--	[CEB]
Vanadium	µg/g	5 / 5	5 / 5	100%	--	--	12	53	30	15	Normal	44	44		92	[bk]
1,3,5-Trinitrobenzene	µg/g	1 / 5	1 / 5	20%	0.084	0.084	1.1	1.1	0.26	0.48	Lognormal	40	1.1	#	--	[CEB]
2,4,6-Trinitrotoluene	µg/g	4 / 7	4 / 7	57%	0.089	0.50	0.16	11	2.2	4.0	Lognormal	1,635	11	#	--	[CEB]
2,4-Dinitrotoluene	µg/g	4 / 5	4 / 5	80%	0.056	0.056	0.22	1.4	0.50	0.55	Normal	1.0	1.0		--	[CEB]
Acetone	µg/g	2 / 5	2 / 5	40%	0.045	0.067	0.025	0.13	0.047	0.047	Lognormal	0.20	0.13	#	--	[CEB]
Benzoic Acid	µg/g	1 / 5	1 / 5	20%	0.92	0.92	5.2	5.2	1.4	2.1	Lognormal	24	5.2	#	--	[CEB]
Ethylbenzene	µg/g	1 / 5	1 / 5	20%	0.0025	0.0025	0.015	0.015	0.0040	0.0061	Lognormal	0.076	0.015	#	--	[CEB]
Toluene	µg/g	1 / 5	1 / 5	20%	0.0025	0.0025	0.0023	0.0023	0.0015	0.00047	Lognormal	0.0020	0.0020		--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)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E 504,200
SB-07-017
SB-07-018
SB-07-016
SB-07-020
SB-07-019
SB-06-011
SB-06-012
SB-06-013
SB-06-014
SB-06-015
25
7
27
27
21
6
STATE PLANE GRID
0 250 500 1000
SCALE: 1" = 500'
E 501,150
N 1,032,800
LEGEND:
BUILDING
SECONDARY ROAD
STUDY AREA
SOIL BORING CONFIRMATION SAMPLE
ALABAMA STATE PLANE GRID (EAST)
SAMPLE LOCATION
SAMPLE DEPTH
0 - <1 FEET
1 - 10 FEET
>10 FEET
ANALYTICAL GROUPS
SVOCs
METALS
VOCs
EXPLOSIVES
U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA
CEBs in Soil at
Study Area 6 and 7
Figure No. 4-21
Project No. 03-8178-045
File Name 99015\DWGS\E42PIE09
Date 03-31-99

72 µg/g in shallow and deep subsurface samples, respectively. The maximum lead concentrations in all three soil intervals were detected in samples collected by Roy F. Weston before the Supplemental RI . Selenium was detected in one of the five deep subsurface samples (>10 feet) collected during the Supplemental RI at 27.1 µg/g. The maximum concentrations of metals that exceeded background at Study Area 6 are also listed in the box adjacent to the beginning of this paragraph.

Explosives—Data collected by Roy F. Weston following the excavation of soils indicated that no explosives remain in soils at concentrations greater than the remediation criteria (100 µg/g TNT). The maximum concentrations of explosives detected at Study Area 6 are listed in the adjacent box. The highest concentration of TNT in surface soil was 10.7 µg/g; this explosive was detected in 6 of the 298 samples analyzed. The TNT breakdown product 2-A-4,6-DNT was detected in two surface soil samples at a maximum concentration of 5.26 µg/g. Tetryl and nitrobenzene each were detected in one surface soil sample, both at 0.7 µg/g. Of the 30 screening samples collected from subsurface soils during the Supplemental RI, the maximum concentration of explosives detected was 7.6 µg/g.

Maximum Concentrations			
Analyte (µg/g)	0-<1ft	1-10ft	>10ft
1,3,5-TNB			1.12*
TNT	10.7	36	11
2,4-DNT			1.43*
2,6-DNT	1		
2-A-4,6-DNT	5.26		
Nitrobenzene	0.7		
Tetryl	0.7	2.7	

All data are from Roy F. Weston except for those marked with a "*". These data are from the Supplemental RI.

Four explosives (TNT, 2,4-DNT, tetryl, and 1,3,5-TNB) were detected in subsurface soil samples that were collected for confirmatory analysis. The maximum TNT concentration detected in shallow subsurface soils was 36 µg/g. TNT was detected in 29 of 47 subsurface soil samples. Tetryl was detected at ≤2.7 µg/g in two shallow subsurface soil samples. 2,4-DNT was detected in four of the five samples collected at depths greater than 10 feet, with a maximum concentration (1.43 µg/g) in the 25-foot interval at location SB-06-012. 1,3,5-TNB was detected in a single sample (SB-06-012) at the same 25-foot interval at 1.12 µg/g.

VOCs—Three VOCs were detected in the Study Area 6 subsurface soils and are listed in the adjacent box. Acetone was detected in four subsurface soil samples at a maximum concentration of 1.6 µg/g. Ethylbenzene was detected in only one sample (SB-06-012; 25 feet BLS). Toluene was detected in three shallow subsurface samples and one deep subsurface sample.

Maximum Concentrations			
Analyte (µg/g)	0-<1ft	1-10ft	>10ft
Acetone		1.6	0.13
Ethylbenzene			0.015
Toluene		0.026	0.0023

SVOCs—Nine PAHs and benzoic acid were detected in the Study Area 6 subsurface soils and are listed in the adjacent box. These PAHs were detected in one sample at the 1-foot interval (SB-06-012). Concentrations ranged from 0.27 µg/g for benzo(g,h,i)perylene to 1.4 µg/g for benzo(b)fluoranthene. Benzoic acid was detected in one deep subsurface sample (SB-06-012; 25 feet BLS).

Maximum Concentrations			
Analyte (µg/g)	0-<1ft	1-10ft	>10ft
Benzo(a)anthracene		0.47	
Benzo(a)pyrene		0.52	
Benzo(b)fluoranthene		1.4	
Benzo(g,h,i)perylene		0.27	
Benzo(k)fluoranthene		0.56	
Benzoic Acid			5.2
Chrysene		0.77	
Fluoranthene		0.98	
Indeno(1,2,3-cd)pyrene		0.31	
Pyrene		1.1	

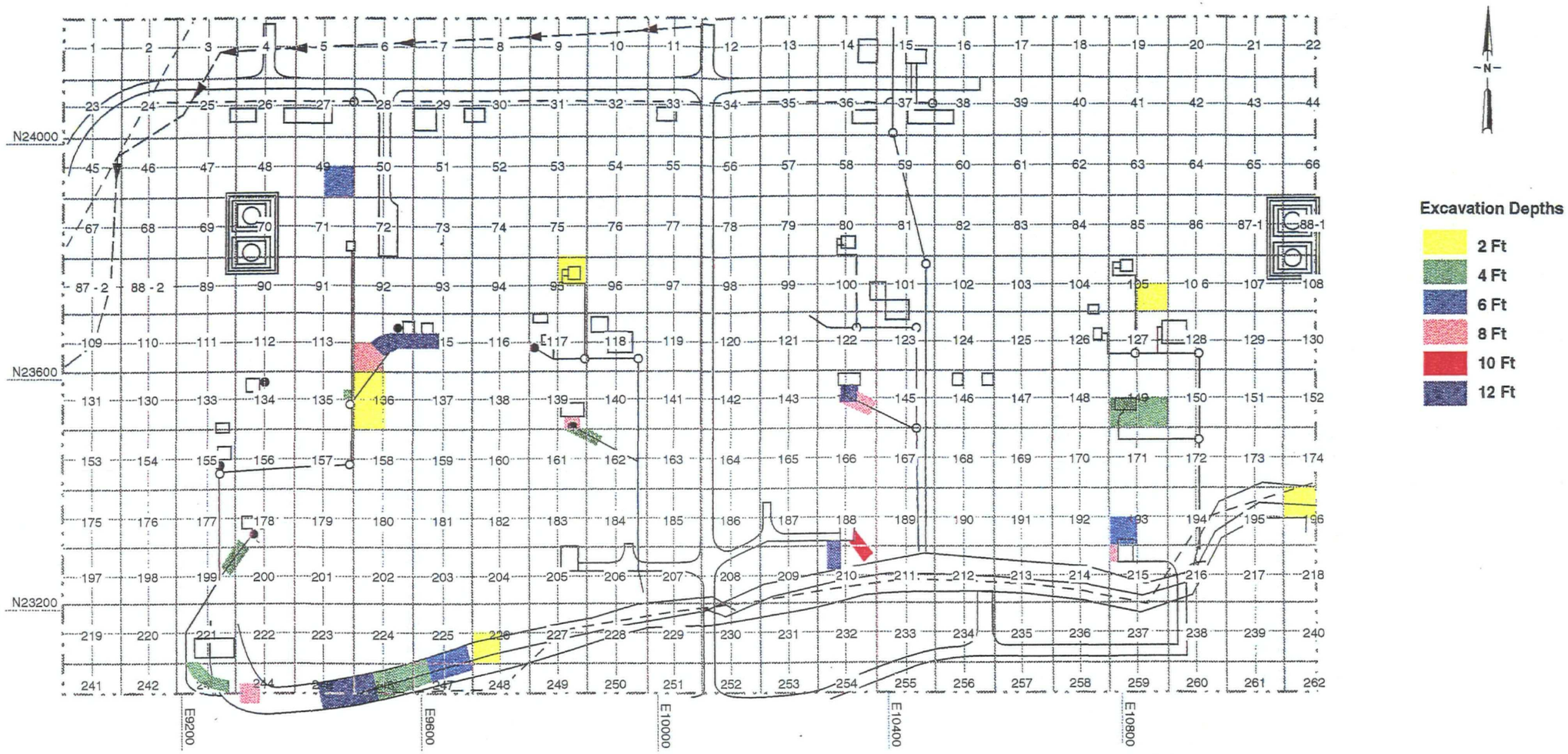
Summary—Study Area 6 is a former manufacturing area for TNT. Previous investigations determined that the area contained explosives contamination in the soils. Roy F. Weston performed remediation activities at this study area and excavated 27,703 cubic yards of explosives-contaminated soils. Confirmatory sampling results indicate that no explosives remain in the soil at concentrations greater than 100 µg/g TNT. Lead remains in the soil at concentrations ≤380 µg/g. Three VOCs (acetone, ethylbenzene, and toluene) were detected in the Study Area 6 soils, but results did not indicate a pattern of contamination. PAHs were detected in the soils at a total concentration of less than 7 µg/g. The presence of PAHs in the soil may be attributable to the burning of buildings in the area.

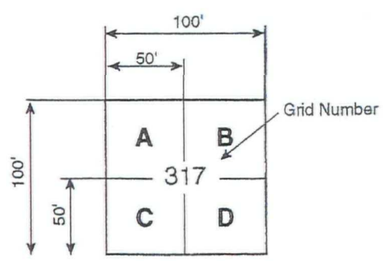
4.5.7 Study Area 7 – Northern TNT Manufacturing Area

Study Area 7 is the Northern TNT Manufacturing Area, which consisted of four TNT lines and one DNT manufacturing line. Previous soil sampling data indicated the presence of TNT and DNT (ESE 1993).

The entire area was sampled by Roy F. Weston on 50-foot grids and samples were screened for explosives. Samples also were analyzed for lead. A screening criteria of 647 µg/g TNT was used as the guideline for remediation. Based on the Roy F. Weston investigation, portions of the study area that contained explosives contamination exceeding 647 µg/g TNT were remediated to levels of 100 µg/g of TNT. **Figure 4-22** shows the areas of contaminated soils that have been excavated and remediated at Study Area 7. A total of 17,120 cubic yards of explosives-contaminated soils were excavated from this area (Weston 1996). Following remediation, confirmatory samples were collected just below the excavation depth to verify that remediation was adequate.

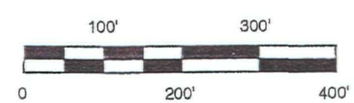
During Phase 1 of the Supplemental RI, five soil borings were placed adjacent to remediated areas in this study area. Twenty-seven samples were screened for explosives in the field. Ten subsurface samples from the five borings were sent to the laboratory for confirmatory analysis of metals, explosives, VOCs, and SVOCs. One additional subsurface sample was analyzed for VOCs only. Two of the samples were analyzed for hexavalent chromium.





Typical Grid

NOTE:
DRAWINGS ARE APPROXIMATELY SCALED BASED UPON PREVIOUS INVESTIGATIVE REPORTS PREPARED BY ESE INC., AND A SITE PLAN PREPARED FOR ALABAMA ORDNANCE WORKS (SANITARY & INDUSTRIAL WASTE SEWERAGE PLANT NO. 2, 1946). SITE FEATURES AND OTHER INFORMATION PROVIDED IN THIS DRAWING WILL BE VERIFIED DURING THE SITE SURVEY AND SUBSEQUENT REMEDIAL ACTIVITIES.



Source: Weston 1995

U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

Areas of Excavation at Study Area 7

Figure No.	Project No.	File Name	Date
4-22	01-0827-03-8178-045	99015\DWGS\E42F4-17	03-31-99

95P-5485 12/4/95

The Roy F. Weston data were combined with the data collected by SAIC during the Supplemental RI for evaluation. The data summary tables for Study Area 7 are presented in Appendices K (SAIC) and L (Roy F. Weston). **Tables 4-28** through **4-30** present summary statistics for the soil samples collected from Study Area 7. Figure 4-21 shows the locations where the general contaminant group CEBs (metals, SVOCs, VOCs, and explosives) were detected in Supplemental RI samples collected at Study Area 7. The lack of quadrants in a circle indicates that a soil sample was not collected at that interval.

Metals—Lead, the only metal analyzed for by Roy F. Weston, was detected in all except one surface soil sample. The maximum detected concentration is listed in the adjacent box. Although surface soil lead concentrations exceeded background, lead concentrations were less than 100 µg/g in surface soils where excavation took place.

Maximum Concentrations*			
Analyte (µg/g)	**0-<1ft**	**1-10ft**	**>10ft**
Aluminum		37,000	28,000
Barium		**173**	50.8
Beryllium		1.73	***4.98***
Calcium		3,360	1,970
Cobalt		7.27	
Lead	98**	**200****	38
Magnesium		1,470	2,170
Manganese		2,100	1,800
Nickel			53.4
Potassium		1,840	1,450
Sodium		**72**	**74**
Vanadium		99	
Zinc		103	

* Metals also determined to exceed background based on ANOVA evaluation are shown in bold.

** Roy F. Weston data.

Thirteen metals were detected at Study Area 7 at concentrations exceeding background in subsurface soils (listed in the adjacent box). Lead concentrations in shallow and deep subsurface soils, including excavation confirmatory samples, were all ≤200 µg/g. The highest concentration of barium was detected in SB-07-018 (see Figure 4-21) at the 1-foot interval at 173 µg/g. The concentration of barium detected in the 25-foot interval of this boring was 50.8 µg/g. Beryllium concentrations increased from the 1-foot BLS samples to the deeper samples in all five Supplemental RI borings.

Explosives—Data collected by Roy F. Weston following the excavation of soils indicated that TNT was removed to concentrations of <100 µg/g. Surface and subsurface concentrations of TNT were all ≤76 µg/g. Five other explosives compounds were detected in the soils that remain at Study Area 7, as indicated in the adjacent box. 2,4-DNT was detected in three of the surface soil samples at a maximum concentration of 26.7 µg/g. 2,6-DNT was detected in two surface soil samples at a maximum concentration of 16.1 µg/g. 2,4-DNT and 2,6-DNT were not detected in the subsurface soil. 1,3,5-TNB, nitrobenzene, and tetryl were detected at concentrations <3 µg/g in surface soils.

Maximum Concentrations*			
Analyte (µg/g)	**0-<1ft**	**1-10ft**	**>10ft**
1,3,5-TNB	1.05	1.5	
TNT	38.7	76	17
2,4-DNT	26.7		
2,6-DNT	16.1		
Nitrobenzene	2.39		
Tetryl	2.06		

* All data are from Roy F. Weston.

Table 4-28. *Summary Statistics and Exposure Point Concentrations for Soil (0-<1 ft BLS) at Study Area 7 - Northern TNT Manufacturing Area*
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:25:58 PM
Run Date: 3/29/99
Exposure Unit: 07_SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]	2 x BK Mean[d]	Background Comparison[g]
Lead	µg/g	154 / 155	154 / 155	99%	50	50	4.3	98	21	18	Lognormal	23	23	34	[CEB][ANOVA]
1,3,5-Trinitrobenzene	µg/g	1 / 155	1 / 155	1%	0.50	0.50	1.1	1.1	0.26	0.064	Lognormal	0.26	0.26	--	[CEB]
2,4,6-Trinitrotoluene	µg/g	5 / 155	5 / 155	3%	0.50	0.50	0.70	39	0.53	3.1	Lognormal	0.33	0.33	--	[CEB]
2,4-Dinitrotoluene	µg/g	3 / 155	3 / 155	2%	0.50	0.50	1.2	27	0.43	2.1	Lognormal	0.30	0.30	--	[CEB]
2,6-Dinitrotoluene	µg/g	2 / 155	2 / 155	1%	0.50	0.50	1.1	16	0.36	1.3	Lognormal	0.29	0.29	--	[CEB]
Nitrobenzene	µg/g	1 / 155	1 / 155	1%	0.50	0.50	2.4	2.4	0.26	0.17	Lognormal	0.26	0.26	--	[CEB]
Tetryl	µg/g	2 / 155	2 / 155	1%	0.50	0.50	0.70	2.1	0.26	0.15	Lognormal	0.27	0.27	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-29. Summary Statistics and Exposure Point Concentrations for Soil (1-10 ft BLS) at Study Area 7 - Northern TNT Manufacturing Area
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:25:58 PM
Run Date: 3/29/99
Exposure Unit: 07_SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	6 / 6	6 / 6	100%	--	--	12,000	37,000	22,833	8,208	Normal	29,585	29,585		27,733	[CEB][ANOVA]
Barium	µg/g	6 / 6	6 / 6	100%	--	--	50	173	88	45	Normal	125	125		64	[CEB]
Beryllium	µg/g	6 / 6	6 / 6	100%	--	--	0.38	1.7	0.85	0.48	Normal	1.2	1.2		0.80	[CEB][ANOVA]
Calcium	µg/g	6 / 6	6 / 6	100%	--	--	894	3,360	1,671	936	Normal	2,440	2,440		2,475	[CEB][ANOVA]
Chromium	µg/g	4 / 6	4 / 6	67%	56	90	23	41	32	9.0	Normal	40	40		46	[bk]
Cobalt	µg/g	3 / 6	3 / 6	50%	2.5	2.5	6.2	7.3	4.1	3.1	Lognormal	23	7.3	#	7.0	[CEB][ANOVA]
Copper	µg/g	6 / 6	6 / 6	100%	--	--	5.2	17	12	4.2	Normal	16	16		26	[bk]
Iron	µg/g	6 / 6	6 / 6	100%	--	--	20,000	30,000	25,500	4,087	Normal	28,862	28,862		52,000	[bk]
Lead	µg/g	35 / 36	35 / 36	97%	10.0	10.0	4.1	200	37	43	Lognormal	51	51		14	[CEB]
Magnesium	µg/g	6 / 6	6 / 6	100%	--	--	368	1,470	1,025	393	Normal	1,348	1,348		1,399	[CEB][ANOVA]
Manganese	µg/g	6 / 6	6 / 6	100%	--	--	113	2,100	704	711	Lognormal	4,228	2,100	#	682	[CEB][ANOVA]
Nickel	µg/g	4 / 6	4 / 6	67%	7.5	7.5	9.8	18	10	5.6	Normal	15	15		21	[bk]
Potassium	µg/g	6 / 6	6 / 6	100%	--	--	370	1,840	1,061	515	Normal	1,485	1,485		1,324	[CEB][ANOVA]
Sodium	µg/g	1 / 6	1 / 6	17%	50	50	72	72	33	19	Lognormal	53	53		--	[CEB]
Vanadium	µg/g	6 / 6	6 / 6	100%	--	--	40	99	56	22	Lognormal	78	78		96	[CEB][ANOVA]
Zinc	µg/g	5 / 6	5 / 6	83%	27	27	27	103	46	31	Normal	71	71		71	[CEB][ANOVA]
1,3,5-Trinitrobenzene	µg/g	2 / 14	2 / 14	14%	0.084	0.25	0.44	1.5	0.21	0.39	Lognormal	0.40	0.40		--	[CEB]
2,4,6-Trinitrotoluene	µg/g	15 / 33	15 / 33	45%	0.089	0.50	0.30	76	7.2	17	Lognormal	62	62		--	[CEB]
Acetone	µg/g	3 / 7	3 / 7	43%	0.018	0.045	0.049	0.28	0.087	0.11	Lognormal	0.97	0.28	#	--	[CEB]
Diethyl Phthalate	µg/g	1 / 6	1 / 6	17%	0.35	0.35	2.0	2.0	0.48	0.75	Lognormal	2.7	2.0	#	--	[CEB]
Methylene Chloride	µg/g	1 / 7	1 / 7	14%	0.0062	0.0062	0.0073	0.0073	0.0037	0.0016	Lognormal	0.0049	0.0049		--	[CEB]
Toluene	µg/g	4 / 7	4 / 7	57%	0.0025	0.0025	0.0016	0.0099	0.0030	0.0031	Lognormal	0.0078	0.0078		--	[CEB]
Total Organic Carbon	µg/g	5 / 6	5 / 6	83%	1000	1000	4,640	16,700	8,422	5,536	Normal	12,975	12,975		--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-30. Summary Statistics and Exposure Point Concentrations for Soil (>10 ft BLS) at Study Area 7 - Northern TNT Manufacturing Area
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:25:58 PM
Run Date: 3/29/99
Exposure Unit: 07_SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	4 / 4	4 / 4	100%	--	--	12,000	28,000	20,000	6,733	Normal	27,923	27,923		27,567	[CEB][ANOVA]
Arsenic	µg/g	1 / 4	1 / 4	25%	13	13	17	17	9.0	5.3	Lognormal	26	17	#	52	[bk]
Barium	µg/g	4 / 4	4 / 4	100%	--	--	29	51	39	12	Normal	53	51	#	41	[CEB][ANOVA]
Beryllium	µg/g	4 / 4	4 / 4	100%	--	--	1.9	5.0	3.9	1.4	Normal	5.5	5.0	#	0.89	[CEB]
Calcium	µg/g	3 / 4	3 / 4	75%	109	109	772	1,970	1,089	850	Normal	2,090	1,970	#	257	[CEB][ANOVA]
Chromium	µg/g	2 / 4	2 / 4	50%	17	36	33	38	24	14	Normal	41	38	#	53	[bk]
Cobalt	µg/g	3 / 4	3 / 4	75%	2.5	2.5	8.5	54	22	23	Normal	49	49		58	[bk]
Copper	µg/g	4 / 4	4 / 4	100%	--	--	15	24	19	4.2	Normal	24	24	#	56	[bk]
Iron	µg/g	4 / 4	4 / 4	100%	--	--	33,000	38,000	36,500	2,380	Normal	39,301	38,000	#	57,000	[bk]
Lead	µg/g	9 / 9	9 / 9	100%	--	--	9.1	38	24	9.5	Normal	30	30		32	[CEB][ANOVA]
Magnesium	µg/g	4 / 4	4 / 4	100%	--	--	656	2,170	1,162	684	Normal	1,967	1,967		867	[CEB][ANOVA]
Manganese	µg/g	4 / 4	4 / 4	100%	--	--	274	1,800	684	745	Lognormal	14,691	1,800	#	1,331	[CEB][ANOVA]
Mercury	µg/g	1 / 4	1 / 4	25%	0.087	0.087	0.13	0.13	0.064	0.042	Lognormal	0.22	0.13	#	0.36	[bk]
Nickel	µg/g	4 / 4	4 / 4	100%	--	--	15	53	32	16	Normal	52	52		46	[CEB][ANOVA]
Potassium	µg/g	4 / 4	4 / 4	100%	--	--	785	1,450	1,129	273	Normal	1,450	1,450		1,206	[CEB][ANOVA]
Sodium	µg/g	1 / 4	1 / 4	25%	50	50	74	74	37	24	Lognormal	127	74	#	--	[CEB]
Vanadium	µg/g	4 / 4	4 / 4	100%	--	--	46	65	54	8.1	Normal	63	63		92	[bk]
Zinc	µg/g	3 / 4	3 / 4	75%	53	53	57	79	59	24	Normal	87	79	#	104	[bk]
2,4,6-Trinitrotoluene	µg/g	5 / 9	5 / 9	56%	0.089	0.089	2.1	17	3.3	5.5	Lognormal	7,219	17	#	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Of the 27 screening samples collected from subsurface soils during the Supplemental RI, the maximum concentration of explosives detected was 5.0 μg/g. Explosives were not detected in any of the subsurface confirmatory soil samples collected during the Supplemental RI.

VOCs—VOCs were detected in 7 of 11 Supplemental RI samples. The maximum concentrations of VOCs detected are listed in the adjacent box. VOCs are limited to the shallow subsurface soils and show no indication of migration. Acetone was detected in three samples, with the highest concentrations (≥0.2 μg/g) in the 1- and 10-foot intervals of boring SB-07-019. Methylene chloride and toluene concentrations were near the CRL. Detected VOC concentrations are not indicative of significant contamination.

Maximum Concentrations			
Analyte (μg/g)	0-<1ft	1-10ft	>10ft
Acetone		>0.28	
Methylene Chloride		0.0073	
Toluene		0.0099	

SVOCs—One SVOC (diethyl phthalate) was detected in one sample collected at Study Area 7. Diethyl phthalate was detected at a concentration of 2 μg/g in the 1-foot BLS sample in boring SB-07-016, but was not detected in the 25-foot BLS interval in the same boring.

Summary—Study Area 7 is a former manufacturing area for TNT and DNT. Previous investigations determined that the area contained explosives contamination in the soils. Remediation activities were performed by Roy F. Weston; 17,120 cubic yards of explosives-contaminated soils were excavated from this area. Results from the confirmatory sampling indicate that soils with explosives contamination in excess of 100 μg/g were removed from Study Area 7. Lead remains in the surface soils at concentrations <100 μg/g and in shallow subsurface soils at concentrations ≤200 μg/g. Inconsistent, low-level detections of VOCs in the shallow subsurface interval and one detection of one SVOC indicate that significant organic contamination is not present in the Study Area 7 soils.

4.5.8 Study Area 8 – Acid/Organic Manufacturing Area

Study Area 8, the Acid/Organic Manufacturing Area, was the site of the production of aniline, N-N-dimethylaniline, concentrated nitric acid, oleum, and sodium sulfite (sellite). Liquid wastes generated from these production activities at Study Area 8 were discharged into part of the Industrial Sewer System (ISS) onsite and were subsequently discharged into either the Red Water Ditch or Coosa River. A former sulfur burning pit that may contain residual sulfur also is located in this area (DA 1978). Particles of sulfur residue up to 1 inch in diameter were abundant on the soil surface in the sulfur storage area. Previous investigations demonstrated that the area is contaminated by sulfur and acid wastes covering approximately 1,615 square feet. In addition, the previous investigation showed that nitrobenzene and lead are present throughout the area (ESE 1981).

4.5.8.1 Surface Soil and Soil Boring Results

To better delineate the magnitude and extent of contamination, 42 soil sampling locations were established at Study Area 8 during Phase 1 of the Supplemental RI. Surface soil samples were collected from all soil sampling locations, and were screened for explosives in a field laboratory, as discussed in Section 4.5.1.1. Surface soil samples collected from 12 of the 42 soil sampling locations were submitted for confirmatory analysis. Twenty-nine subsurface soil samples were collected from five soil borings drilled at Study Area 8 and were screened for explosives in the field laboratory. One shallow subsurface soil sample and one deep subsurface soil sample were collected from each of the five soil borings and submitted for confirmatory analysis. Soil samples submitted for confirmatory analysis were analyzed for metals, explosives, VOCs, and SVOCs. Four surface soil and two shallow subsurface soil samples were submitted for hexavalent chromium analysis.

Appendix K presents the data summary tables for Study Area 8. **Tables 4-31** through **4-33** present summary statistics for Study Area 8 surface soil and soil boring samples. **Figure 4-23** shows the locations where the general contaminant group CEBs (metals, SVOCs, VOCs, and explosives) were detected in Study Area 8 surface soil and soil borings. The lack of quadrants in a circle indicates that a soil sample was not collected at that interval. Sheets 4-5 and 4-6 present screening results for surface and subsurface soils, respectively, at Study Area 8. Sheets 4-7 and 4-8 present laboratory confirmatory results for lead and 2,4-DNT, respectively, in surface soils.

Metals—Nineteen metals were detected in Study Area 8 soils at concentrations exceeding background. The metals and their maximum concentration in each soil interval where concentrations exceeded background are listed in the adjacent box.

Maximum Concentrations*			
Analyte (µg/g)	**0-<1ft**	**1-10ft**	**>10ft**
Aluminum	22,000	37,000	
Arsenic	37.8		
Barium	**337**	123	48.9
Beryllium	**3.74**	1.71	1.65
Calcium	52,000	12,000	1,380
Chromium		**71.5**	121
Cobalt	59.2	14.2	
Copper	**172**	27.3	
Iron	**140,000**	99,000	72,000
Lead	**619**	1,000	34.8
Magnesium	10,000	2,320	1,030
Manganese	2,800	1,500	
Mercury	**0.47**		
Molybdenum	23.9		
Nickel	**11,000**	23.3	
Potassium	3,070	1,420	1,830
Sodium		**121**	**69**
Vanadium	103	158	133
Zinc	**371**	77.9	

* Metals also determined to exceed background based on ANOVA evaluation are shown in bold.

Concentrations of metals exceeded background in at least one interval at all but one sampling location, indicating that metals contamination extends across the study area. In surface soils, the highest metal concentrations were reported on the western side of the manufacturing area, at sampling locations SS-08-0010, SS-08-1025, and SS-08-1510. The concentrations of metals in Study Area 8 surface soils were high relative to other surface soils sampled throughout Area B during the investigation—surface soil samples collected

Table 4-31. Summary Statistics and Exposure Point Concentrations for Soil (0-<1 ft BLS) at Study Area 8 - Acid/Organic Manufacturing Area
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:30:05 PM
Run Date: 3/29/99
Exposure Unit: 08_SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[g]	Background Comparison[h]
Aluminum	µg/g	11 / 11	11 / 11	100%	--	--	11,000	22,000	15,636	3,443	Normal	17,518	17,518		20,277	[CEB][ANOVA]
Arsenic	µg/g	6 / 11	6 / 11	55%	13	13	16	38	18	13	Normal	25	25		15	[CEB][ANOVA]
Barium	µg/g	11 / 11	11 / 11	100%	--	--	69	337	179	96	Normal	231	231		124	[CEB]
Beryllium	µg/g	11 / 11	11 / 11	100%	--	--	0.53	3.7	1.5	1.1	Lognormal	2.6	2.6		0.82	[CEB]
Calcium	µg/g	11 / 11	11 / 11	100%	--	--	195	52,000	14,509	18,802	Lognormal	261,148	52,000	#	4,960	[CEB][ANOVA]
Chromium	µg/g	1 / 11	1 / 11	9%	27	18,000	36	36	840	2,707	Lognormal	3,498	36	#	54	[bk]
Cobalt	µg/g	6 / 11	6 / 11	55%	2.5	2.5	3.2	59	8.0	17	Lognormal	21	21		14	[CEB][ANOVA]
Copper	µg/g	11 / 11	11 / 11	100%	--	--	7.0	172	49	52	Lognormal	182	172	#	13	[CEB]
Iron	µg/g	11 / 11	11 / 11	100%	--	--	30,000	140,000	59,000	31,148	Lognormal	78,367	78,367		37,560	[CEB]
Lead	µg/g	11 / 11	11 / 11	100%	--	--	22	619	134	175	Lognormal	393	393		34	[CEB]
Magnesium	µg/g	11 / 11	11 / 11	100%	--	--	302	10,000	2,811	3,521	Lognormal	9,233	9,233		1,189	[CEB][ANOVA]
Manganese	µg/g	11 / 11	11 / 11	100%	--	--	480	2,800	1,420	789	Normal	1,851	1,851		1,730	[CEB][ANOVA]
Mercury	µg/g	3 / 11	3 / 11	27%	0.087	0.087	0.17	0.47	0.11	0.14	Lognormal	0.24	0.24		0.056	[CEB]
Molybdenum	µg/g	2 / 11	2 / 11	18%	4.0	4.0	14	24	5.1	7.2	Lognormal	10	10		--	[CEB]
Nickel	µg/g	8 / 11	8 / 11	73%	7.5	7.5	9.1	11,000	1,026	3,308	Lognormal	39,109	11,000	#	9.4	[CEB]
Potassium	µg/g	11 / 11	11 / 11	100%	--	--	435	3,070	1,078	838	Lognormal	1,782	1,782		680	[CEB][ANOVA]
Sodium	µg/g	8 / 11	8 / 11	73%	50	50	60	374	124	125	Lognormal	310	310		501	[bk]
Vanadium	µg/g	11 / 11	11 / 11	100%	--	--	32	103	64	20	Normal	75	75		76	[CEB][ANOVA]
Zinc	µg/g	11 / 11	11 / 11	100%	--	--	24	371	121	115	Lognormal	309	309		36	[CEB]
2,4-Dinitrotoluene	µg/g	2 / 11	2 / 11	18%	0.054	0.054	0.12	2.4	0.25	0.70	Lognormal	0.61	0.61		--	[CEB]
2-Methylnaphthalene	µg/g	1 / 11	1 / 11	9%	0.17	0.17	0.67	0.67	0.14	0.18	Lognormal	0.20	0.20		--	[CEB]
Acenaphthene	µg/g	1 / 11	1 / 11	9%	0.27	0.27	4.6	4.6	0.54	1.3	Lognormal	0.94	0.94		--	[CEB]
Acenaphthylene	µg/g	2 / 11	2 / 11	18%	0.27	0.27	0.45	0.75	0.22	0.20	Lognormal	0.33	0.33		--	[CEB]
Anthracene	µg/g	2 / 11	2 / 11	18%	0.17	0.17	0.63	7.1	0.77	2.1	Lognormal	2.3	2.3		--	[CEB]
Benzo(a)anthracene	µg/g	4 / 11	4 / 11	36%	0.17	0.17	0.22	19	2.0	5.7	Lognormal	16	16		--	[CEB]
Benzo(a)pyrene	µg/g	4 / 11	4 / 11	36%	0.24	0.24	0.24	14	1.7	4.2	Lognormal	8.9	8.9		--	[CEB]
Benzo(b)fluoranthene	µg/g	3 / 11	3 / 11	27%	0.73	0.73	0.60	20	2.5	5.9	Lognormal	7.7	7.7		--	[CEB]
Benzo(g,h,i)perylene	µg/g	2 / 11	2 / 11	18%	0.25	0.25	1.9	10.0	1.2	3.0	Lognormal	4.7	4.7		--	[CEB]
Benzo(k)fluoranthene	µg/g	2 / 11	2 / 11	18%	0.40	0.40	2.5	8.3	1.1	2.5	Lognormal	3.5	3.5		--	[CEB]
Benzoic Acid	µg/g	1 / 11	1 / 11	9%	0.92	0.92	4.5	4.5	0.83	1.2	Lognormal	1.2	1.2		--	[CEB]
Chrysene	µg/g	4 / 11	4 / 11	36%	0.27	0.27	0.30	19	2.2	5.7	Lognormal	13	13		--	[CEB]
Dibenzo(a,h)anthracene	µg/g	2 / 11	2 / 11	18%	0.27	0.27	0.32	3.1	0.42	0.89	Lognormal	0.74	0.74		--	[CEB]
Dibenzofuran	µg/g	1 / 11	1 / 11	9%	0.17	0.17	1.8	1.8	0.24	0.52	Lognormal	0.39	0.39		--	[CEB]
Fluoranthene	µg/g	4 / 11	4 / 11	36%	0.17	0.17	0.49	60	6.2	18	Lognormal	281	60	#	--	[CEB]
Fluorene	µg/g	1 / 11	1 / 11	9%	0.17	0.17	3.6	3.6	0.40	1.1	Lognormal	0.72	0.72		--	[CEB]
Indeno(1,2,3-cd)pyrene	µg/g	4 / 11	4 / 11	36%	0.17	0.17	0.100	8.3	0.97	2.5	Lognormal	4.2	4.2		--	[CEB]
N-Nitrosodiphenylamine	µg/g	3 / 11	3 / 11	27%	0.17	0.17	0.15	0.36	0.13	0.093	Lognormal	0.19	0.19		--	[CEB]
Naphthalene	µg/g	1 / 11	1 / 11	9%	0.17	0.17	1.4	1.4	0.20	0.40	Lognormal	0.32	0.32		--	[CEB]
Phenanthrene	µg/g	4 / 11	4 / 11	36%	0.17	0.17	0.13	30	2.9	9.0	Lognormal	18	18		--	[CEB]
Pyrene	µg/g	2 / 11	2 / 11	18%	0.97	0.97	4.0	33	3.8	9.8	Lognormal	11	11		--	[CEB]
Styrene	µg/g	1 / 11	1 / 11	9%	0.0025	0.0025	0.0024	0.0024	0.0014	0.00035	Lognormal	0.0015	0.0015		--	[CEB]
Tetryl	µg/g	1 / 11	1 / 11	9%	0.093	0.093	0.21	0.21	0.062	0.051	Lognormal	0.081	0.081		--	[CEB]
Toluene	µg/g	9 / 11	9 / 11	82%	0.0025	0.0025	0.0022	0.014	0.0053	0.0045	Lognormal	0.011	0.011		--	[CEB]
Total Organic Carbon	µg/g	11 / 11	11 / 11	100%	--	--	8,670	115,000	50,225	30,773	Normal	67,041	67,041		--	[CEB]

Table 4-31. Summary Statistics and Exposure Point Concentrations for Soil (0-<1 ft BLS) at Study Area 8 - Acid/Organic Manufacturing Area (Continued)
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:30:05 PM
Run Date: 3/29/99
Exposure Unit: 08_SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]	2 x BK Mean[d]	Background Comparison[g]
bis(2-Ethylhexyl)phthalate	µg/g	1 / 11	1 / 11	9%	0.19	0.19	0.15	0.15	0.100	0.017	Lognormal	0.11	0.11	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-32. Summary Statistics and Exposure Point Concentrations for Soil (1-10 ft BLS) at Study Area 8 - Acid/Organic Manufacturing Area
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:30:05 PM
Run Date: 3/29/99
Exposure Unit: 08_SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	5 / 5	5 / 5	100%	--	--	10,000	37,000	24,400	11,718	Normal	35,571	35,571		27,733	[CEB][ANOVA]
Arsenic	µg/g	3 / 5	3 / 5	60%	13	13	18	24	15	8.1	Normal	23	23		42	[bk]
Barium	µg/g	5 / 5	5 / 5	100%	--	--	27	123	66	40	Normal	105	105		64	[CEB][ANOVA]
Beryllium	µg/g	5 / 5	5 / 5	100%	--	--	0.37	1.7	0.99	0.54	Normal	1.5	1.5		0.80	[CEB][ANOVA]
Calcium	µg/g	4 / 5	4 / 5	80%	109	109	277	12,000	2,974	5,097	Lognormal	1.04E+08	12,000	#	2,475	[CEB][ANOVA]
Chromium	µg/g	5 / 5	5 / 5	100%	--	--	33	72	51	16	Normal	66	66		46	[CEB]
Cobalt	µg/g	2 / 5	2 / 5	40%	2.5	2.5	11	14	5.8	6.3	Normal	12	12		7.0	[CEB][ANOVA]
Copper	µg/g	4 / 5	4 / 5	80%	3.4	3.4	16	27	17	9.8	Normal	27	27		26	[CEB][ANOVA]
Iron	µg/g	5 / 5	5 / 5	100%	--	--	24,000	99,000	59,200	28,595	Normal	86,463	86,463		52,000	[CEB][ANOVA]
Lead	µg/g	4 / 5	4 / 5	80%	10.0	10.0	20	1000	221	436	Lognormal	2.47E+06	1000	#	14	[CEB][ANOVA]
Magnesium	µg/g	5 / 5	5 / 5	100%	--	--	302	2,320	1,026	817	Normal	1,805	1,805		1,399	[CEB][ANOVA]
Manganese	µg/g	5 / 5	5 / 5	100%	--	--	175	1,500	671	527	Normal	1,174	1,174		682	[CEB][ANOVA]
Nickel	µg/g	3 / 5	3 / 5	60%	7.5	7.5	16	23	13	8.7	Normal	21	21		21	[CEB][ANOVA]
Potassium	µg/g	5 / 5	5 / 5	100%	--	--	303	1,420	884	505	Normal	1,366	1,366		1,324	[CEB][ANOVA]
Sodium	µg/g	4 / 5	4 / 5	80%	50	50	64	121	74	36	Normal	107	107		--	[CEB]
Vanadium	µg/g	5 / 5	5 / 5	100%	--	--	38	158	97	45	Normal	140	140		96	[CEB][ANOVA]
Zinc	µg/g	4 / 5	4 / 5	80%	70	70	23	78	49	22	Normal	70	70		71	[CEB][ANOVA]
2,4,6-Trinitrotoluene	µg/g	1 / 5	1 / 5	20%	0.079	0.089	0.16	0.16	0.065	0.055	Lognormal	0.19	0.16	#	--	[CEB]
2,4-Dinitrotoluene	µg/g	1 / 5	1 / 5	20%	0.054	0.056	1.3	1.3	0.29	0.58	Lognormal	335	1.3	#	--	[CEB]
Acetone	µg/g	4 / 4	4 / 4	100%	--	--	0.032	1.00	0.45	0.49	Normal	1.0	1.00	#	--	[CEB]
Benzo(a)anthracene	µg/g	2 / 5	2 / 5	40%	0.17	0.17	0.11	0.65	0.20	0.25	Lognormal	1.4	0.65	#	--	[CEB]
Benzo(a)pyrene	µg/g	1 / 5	1 / 5	20%	0.24	0.24	0.57	0.57	0.21	0.20	Lognormal	0.75	0.57	#	--	[CEB]
Benzo(b)fluoranthene	µg/g	1 / 5	1 / 5	20%	0.73	0.73	1.4	1.4	0.57	0.46	Lognormal	1.5	1.4	#	--	[CEB]
Chrysene	µg/g	1 / 5	1 / 5	20%	0.27	0.27	0.87	0.87	0.28	0.33	Lognormal	1.6	0.87	#	--	[CEB]
Cyclotetramethylenetetranitramine	µg/g	1 / 5	1 / 5	20%	0.16	0.16	0.55	0.55	0.17	0.21	Lognormal	1.1	0.55	#	--	[CEB]
Fluoranthene	µg/g	1 / 5	1 / 5	20%	0.17	0.17	1.3	1.3	0.33	0.54	Lognormal	11	1.3	#	--	[CEB]
Indeno(1,2,3-cd)pyrene	µg/g	1 / 5	1 / 5	20%	0.17	0.17	0.26	0.26	0.12	0.078	Lognormal	0.25	0.25		--	[CEB]
Methylene Chloride	µg/g	2 / 4	2 / 4	50%	0.0062	0.0078	0.0057	0.0076	0.0051	0.0020	Normal	0.0074	0.0074		--	[CEB]
Phenanthrene	µg/g	2 / 5	2 / 5	40%	0.17	0.17	0.17	0.64	0.21	0.24	Lognormal	1.5	0.64	#	--	[CEB]
Pyrene	µg/g	1 / 5	1 / 5	20%	0.97	0.97	1.3	1.3	0.65	0.36	Lognormal	1.2	1.2		--	[CEB]
Toluene	µg/g	1 / 4	1 / 4	25%	0.0025	0.0025	0.0064	0.0064	0.0025	0.0026	Lognormal	0.035	0.0064	#	--	[CEB]
Total Organic Carbon	µg/g	3 / 5	3 / 5	60%	1000	1000	3,120	6,660	3,098	2,683	Normal	5,656	5,656		--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.

[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).

[c] CRL - contract reporting limit.

[d] *Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).*

[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.

[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.

[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.

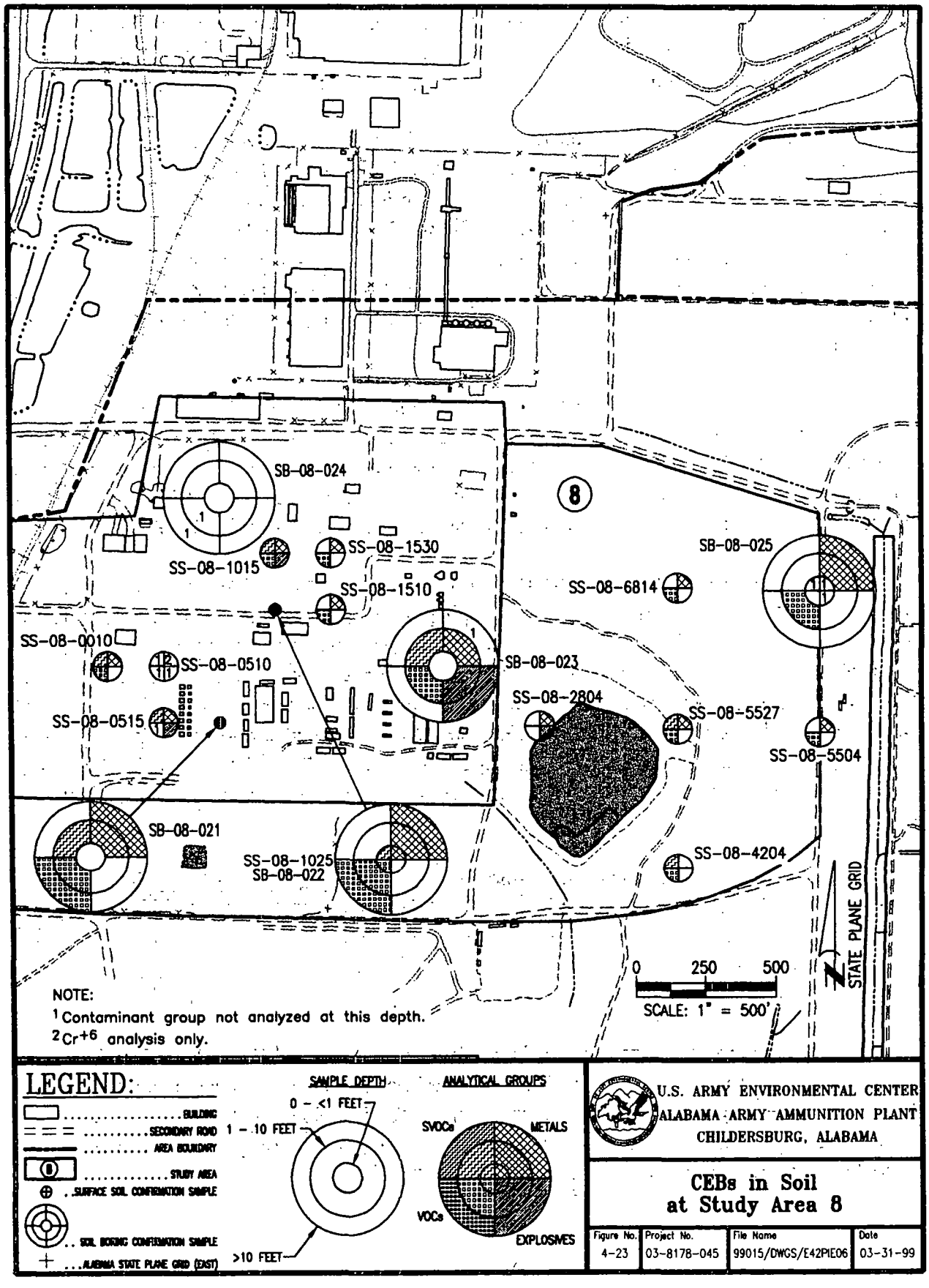
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-33. Summary Statistics and Exposure Point Concentrations for Soil (>10 ft BLS) at Study Area 8 - Acid/Organic Manufacturing Area
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:30:05 PM
Run Date: 3/29/99
Exposure Unit: 08_SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	4 / 4	4 / 4	100%	--	--	14,000	18,000	15,750	1,708	Normal	17,760	17,760		27,567	[bk]
Arsenic	µg/g	3 / 4	3 / 4	75%	13	13	23	30	22	11	Normal	35	30	#	52	[bk]
Barium	µg/g	4 / 4	4 / 4	100%	--	--	15	49	27	16	Normal	45	45		41	[CEB][ANOVA]
Beryllium	µg/g	4 / 4	4 / 4	100%	--	--	0.72	1.7	1.1	0.45	Normal	1.6	1.6		0.89	[CEB][ANOVA]
Calcium	µg/g	2 / 4	2 / 4	50%	109	109	470	1,380	490	625	Normal	1,225	1,225		257	[CEB][ANOVA]
Chromium	µg/g	4 / 4	4 / 4	100%	--	--	19	121	56	46	Normal	110	110		53	[CEB][ANOVA]
Cobalt	µg/g	2 / 4	2 / 4	50%	2.5	2.5	11	21	8.6	9.3	Normal	19	19		58	[bk]
Copper	µg/g	4 / 4	4 / 4	100%	--	--	16	25	19	3.9	Normal	24	24		56	[bk]
Iron	µg/g	4 / 4	4 / 4	100%	--	--	39,000	72,000	53,500	14,387	Normal	70,429	70,429		57,000	[CEB][ANOVA]
Lead	µg/g	4 / 4	4 / 4	100%	--	--	15	35	25	9.5	Normal	36	35	#	32	[CEB][ANOVA]
Magnesium	µg/g	4 / 4	4 / 4	100%	--	--	233	1,030	546	343	Normal	950	950		867	[CEB][ANOVA]
Manganese	µg/g	4 / 4	4 / 4	100%	--	--	122	980	428	392	Normal	889	889		1,331	[bk]
Mercury	µg/g	1 / 4	1 / 4	25%	0.087	0.087	0.12	0.12	0.062	0.037	Lognormal	0.18	0.12	#	0.36	[bk]
Nickel	µg/g	3 / 4	3 / 4	75%	7.5	7.5	13	20	14	7.0	Normal	22	20	#	46	[bk]
Potassium	µg/g	4 / 4	4 / 4	100%	--	--	326	1,830	892	693	Normal	1,708	1,708		1,206	[CEB][ANOVA]
Sodium	µg/g	2 / 4	2 / 4	50%	50	50	67	69	46	25	Normal	75	69	#	--	[CEB]
Vanadium	µg/g	4 / 4	4 / 4	100%	--	--	44	133	83	40	Normal	130	130		92	[CEB][ANOVA]
Zinc	µg/g	3 / 4	3 / 4	75%	46	46	38	67	43	18	Normal	65	65		104	[bk]
2,4-Dinitrotoluene	µg/g	1 / 5	1 / 5	20%	0.054	0.056	0.15	0.15	0.052	0.056	Lognormal	0.23	0.15	#	--	[CEB]
Acetone	µg/g	1 / 4	1 / 4	25%	0.045	0.045	0.024	0.024	0.023	0.00075	Lognormal	0.024	0.024	#	--	[CEB]
Methylene Chloride	µg/g	2 / 4	2 / 4	50%	0.0062	0.0062	0.0094	0.0097	0.0063	0.0037	Normal	0.011	0.0097	#	--	[CEB]
Toluene	µg/g	1 / 4	1 / 4	25%	0.0025	0.0025	0.0019	0.0019	0.0014	0.00032	Lognormal	0.0019	0.0019	#	--	[CEB]
Total Organic Carbon	µg/g	1 / 5	1 / 5	20%	1000	1000	1,420	1,420	684	411	Lognormal	1,336	1,336		--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)


SB-08-024
SS-08-1015
SS-08-1530
SS-08-1510
8
SB-08-025
SS-08-6814
SS-08-0010
SS-08-0510
SB-08-023
SS-08-0515
SS-08-2804
SS-08-5527
SS-08-5504
SB-08-021
SS-08-1025
SB-08-022
SS-08-4204
STATE PLANE GRID
0 250 500
SCALE: 1" = 500'
NOTE:
1 Contaminant group not analyzed at this depth.
2 Cr+6 analysis only.
LEGEND:
BUILDING
SECONDARY ROAD
AREA BOUNDARY
STUDY AREA
SURFACE SOIL CONFIRMATION SAMPLE
SOIL BORING CONFIRMATION SAMPLE
ALABAMA STATE PLANE GRID (EAST)
SAMPLE DEPTH
0 - <1 FEET
1 - 10 FEET
>10 FEET
ANALYTICAL GROUPS
SVOCs
METALS
VOCs
EXPLOSIVES
U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA
CEBs in Soil
at Study Area 8
Figure No. 4-23
Project No. 03-8178-045
File Name 99015/DWGS/E42PIE06
Date 03-31-99

from Study Area 8 contained among the highest concentrations of cobalt, iron, molybdenum, and nickel detected during the Supplemental RI. The maximum surface soil concentrations of four of these metals (cobalt, iron, molybdenum, and nickel) were detected at location SS-08-1025.

Concentrations of barium, cobalt, copper, lead, mercury, molybdenum, nickel, and zinc decreased with increasing sample depth at location SS-08-1025/SS-08-022. Maximum concentrations of 11 of 16 metals exceeding background in shallow subsurface soils were detected in the samples collected at 1 foot BLS from SB-08-022 and SB-08-023. The concentration of vanadium reported in shallow subsurface sample SB-08-023 (158 µg/g) was the highest vanadium concentration detected in shallow subsurface soils collected throughout Area B during the Supplemental RI. Metals did not exceed background in either the shallow or deep subsurface samples at location SB-08-024.

Lead concentrations in 9 of 12 surface soil samples exceeded background. Lead concentrations also exceeded background in all shallow subsurface soil samples, except the sample collected at SB-08-024. The maximum lead concentration in shallow subsurface soils was 1,000 µg/g at SB-08-023. A metals sample was not collected from the 25-foot BLS interval at this location. Lead exceeded background in only one deep subsurface soil sample (SB-08-021).

Explosives—Explosives were detected in 8 of the 42 surface soil samples screened in the field for explosives (Sheet 4-5). The surface sampling locations at which explosives were detected were irregularly distributed across the study area. The highest concentration (25 µg/g) was reported at a location where adjacent surface samples also contained detectable concentrations of explosives (5.85 and 3.25 µg/g). Explosives were detected at concentrations no greater than 5 µg/g in 10 of 29 subsurface samples screened in the field. The subsurface screening samples in which explosives were detected were collected from borings SB-08-021, SB-08-022, and SB-08-024 (Sheet 4-6). Explosives were not detected in any of the subsurface samples screened from borings SB-08-023 or SB-08-025.

Three target explosives and one nontarget explosive (HMX) were detected in Study Area 8 soils submitted for confirmatory analysis. The explosives and their maximum concentrations in each soil interval are listed in the adjacent box.

Maximum Concentrations			
Analyte (µg/g)	0-<1ft	1-10ft	>10ft
2,4-Dinitrotoluene	2.37	1.33	0.152
HMX		0.551	
TNT		0.163	
Tetryl	0.214		

2,4-DNT and tetryl were reported in confirmatory analyses of Study Area 8 surface soils (Table 4-31). 2,4-DNT was detected at two surface sampling locations (SS-08-1015 and SS-08-2804) (see Sheet 4-8); explosives had been detected at SS-08-1015 during the screening survey of the study area. Tetryl was detected at one surface sampling location (SS-08-0515), located in the southwestern quadrant of the study area.

2,4-DNT, TNT, and HMX were detected in one shallow subsurface soil sample collected from a depth of 1 foot BLS (SB-08-023). 2,4-DNT also was reported in the deep subsurface sample (25 feet BLS) collected from the same location at a concentration approximately one order of magnitude lower than in the sample collected at 1 foot BLS. Boring SB-08-023 was drilled at the same sampling location where the highest concentration of explosives (25 µg/g) was detected in surface soils during the field screening survey at Study Area 8.

VOCs—Four VOCs were detected in soils at Study Area 8 and are listed in the adjacent box. Results of acetone analyses for samples collected before June 19, 1995 (as was the 1-foot BLS sample from SB-08-022), are believed to be suspect as a result of field laboratory activities. (Section 4.2 provides an additional explanation.)

Maximum Concentrations			
Analyte (µg/g)	0-<1ft	1-10ft	>10ft
Acetone		1	0.024
Methylene Chloride		0.0076	0.0097
Styrene	0.0024		
Toluene	0.014	0.0064	0.0019

Acetone was detected above the CRL in only two of the Study Area 8 samples. Concentrations of methylene chloride, toluene, and styrene reported in samples collected at Study Area 8 were near or below the detection limits; consequently, these concentrations are not indicative of significant VOC contamination in the surface and subsurface soils.

SVOCs—Twenty-one SVOCs were detected in Study Area 8 soils. The SVOCs and their maximum concentrations in each soil interval are listed in the adjacent box. SVOCs were detected in 6 (SS-08-0010, SS-08-0515, SS-08-1015, SS-08-1025, SS-08-4204, and SS-08-5527) of the 11 surface soil samples analyzed for SVOCs. N-Nitrosodiphenylamine was the only nitrogen-containing SVOC detected. With the exception of acenaphthylene, benzoic acid, B2EHP, and N-Nitrosodiphenylamine, the highest concentrations of SVOCs in surface soils occurred at sampling location SS-08-0515.

Maximum Concentrations			
Analyte (µg/g)	0-<1ft	1-10ft	>10ft
Acenaphthene	4.6		
Acenaphthylene	0.75		
Anthracene	7.1		
B2EHP	0.15		
Benzo(a)anthracene	19	0.65	
Benzo(a)pyrene	14	0.57	
Benzo(b)fluoranthene	20	1.4	
Benzo(g,h,i)perylene	10		
Benzo(k)fluoranthene	8.3		
Benzoic acid	4.5		
Chrysene	19	0.87	
Dibenzo(a,h)anthracene	3.1		
Dibenzofuran	1.8		
Fluoranthene	60	1.3	
Fluorene	3.6		
Indeno(1,2,3-cd)pyrene	8.3	0.26	
2-Methylnaphthalene	0.67		
N-Nitrosodiphenylamine	0.36		
Naphthalene	1.4		
Phenanthrene	30	0.64	
Pyrene	33	1.3	

Eight SVOCs (benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, chrysene, fluoranthene, indeno[1,2,3-cd]pyrene, phenanthrene, and pyrene) were detected in both surface and shallow subsurface soils. Six of the eight SVOCs were detected at only one shallow subsurface location (SB-08-021 at 1 foot BLS) located immediately to the southeast of SS-08-0515 in the southwestern corner of the study area.

Benzo(a)anthracene and phenanthrene also were detected in the 1-foot BLS interval at location SB-08-023. None of the SVOCs was detected in deep subsurface soils.

Summary—The distribution of metals throughout Study Area 8 is random and does not show a trend toward a single source of contamination, although in surface soils, metals concentrations are highest in the western portion of the study area. The activities and processes of the area when it was active were conducive to the release of metals in the soils, and metals concentrations at Study Area 8 were high relative to other study areas.

The most obvious results of the sampling and analysis were the detection of the many PAHs in the surface and subsurface soils predominantly in the western portion of the study area. Twenty-one SVOCs were detected in the surface soil samples at concentrations as high as 60 µg/g. SVOCs were not detected in any of the deep subsurface soil samples collected at the study area. The source of these compounds is likely to be the production of organic chemicals during the active period of the installation.

Concentrations of explosives detected during field screening analysis of soils at Study Area 8 did not exceed 25 µg/g. Three target explosives and one nontarget explosive were detected at low concentrations (less than 3 µg/g) in confirmatory analyses. The four locations in which explosives were detected were distributed irregularly across the study area. Only one compound (2,4-DNT) at one location was detected in the deep surface sampling locations. Although contamination is randomly distributed, the results indicate that subsurface soils in four of five locations do not have explosives migration to the subsurface.

Four VOCs were detected in the surface soil and soil boring samples at Study Area 8. The majority of VOC detections were near or below the CRL.

4.5.8.2 Test Pit Results

During Phase 4A of the Supplemental RI, test pits were excavated at five ISS manhole locations to determine if organic or metal contamination had migrated from selected manhole structures into the surrounding soils. Two samples were collected from each test pit. One soil sample was collected at a depth comparable to the bottom of the manhole concrete cast and the second soil sample was collected at a depth approximately 2 feet below the bottom of the concrete cast. The 10 soil samples collected from the test pit excavations were sent to the laboratory and analyzed for soil pH, metals, and SVOCs.

Appendix K presents the data summary tables for Study Area 8. **Tables 4-34** and **4-35** present summary statistics for Study Area 8 test pit soil samples. **Figure 4-24** shows the locations where the general contaminant group CEBs (metals and SVOCs) were detected in the Study Area 8 test pit soils. A lack of quadrants in a circle indicates that a sample was not collected in that interval.

Table 4-34. Summary Statistics and Exposure Point Concentrations for Soil (1-10 ft BLS) at Study Area 8 Test Pits - Acid/Organic Manufacturing Area
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:32:05 PM
Run Date: 3/29/99
Exposure Unit: 08_SD2

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	5 / 5	5 / 5	100%	--	--	14,900	23,400	19,040	4,012	Normal	22,865	22,865		27,733	[bk]
Antimony	µg/g	4 / 5	4 / 5	80%	20	20	52	70	53	25	Lognormal	378	70	#	--	[CEB]
Arsenic	µg/g	5 / 5	5 / 5	100%	--	--	13	60	33	18	Normal	51	51		42	[CEB][ANOVA]
Barium	µg/g	5 / 5	5 / 5	100%	--	--	13	195	55	78	Lognormal	829	195	#	64	[CEB][ANOVA]
Calcium	µg/g	5 / 5	5 / 5	100%	--	--	200	1,520	757	527	Normal	1,259	1,259		2,475	[bk]
Chromium	µg/g	5 / 5	5 / 5	100%	--	--	11	68	39	22	Normal	59	59		46	[CEB][ANOVA]
Cobalt	µg/g	1 / 5	1 / 5	20%	2.5	2.5	3.4	3.4	1.7	0.96	Lognormal	3.1	3.1		7.0	[bk]
Copper	µg/g	5 / 5	5 / 5	100%	--	--	9.5	26	18	6.0	Normal	24	24		26	[CEB][ANOVA]
Iron	µg/g	5 / 5	5 / 5	100%	--	--	15,700	320,000	114,020	118,773	Lognormal	2.23E+06	320,000	#	52,000	[CEB][ANOVA]
Lead	µg/g	5 / 5	5 / 5	100%	--	--	19	167	51	65	Lognormal	398	167	#	14	[CEB]
Magnesium	µg/g	5 / 5	5 / 5	100%	--	--	188	659	429	189	Normal	610	610		1,399	[bk]
Manganese	µg/g	5 / 5	5 / 5	100%	--	--	37	264	137	99	Normal	232	232		682	[bk]
Mercury	µg/g	1 / 5	1 / 5	20%	0.050	0.050	0.067	0.067	0.033	0.019	Lognormal	0.061	0.061		0.12	[bk]
Nickel	µg/g	4 / 5	4 / 5	80%	2.7	2.7	8.1	12	8.1	4.0	Normal	12	12	#	21	[bk]
Potassium	µg/g	5 / 5	5 / 5	100%	--	--	375	1,040	677	321	Normal	983	983		1,324	[bk]
Vanadium	µg/g	5 / 5	5 / 5	100%	--	--	23	124	83	38	Normal	119	119		96	[CEB][ANOVA]
Zinc	µg/g	5 / 5	5 / 5	100%	--	--	19	36	30	7.0	Normal	37	36	#	71	[bk]
Phenol	µg/g	1 / 5	1 / 5	20%	0.052	0.052	0.11	0.11	0.043	0.038	Lognormal	0.13	0.11	#	--	[CEB]
pH	µg/g	5 / 5	5 / 5	100%	--	--	5.3	6.4	5.7	0.45	Normal	6.1	6.1		--	[CEB]

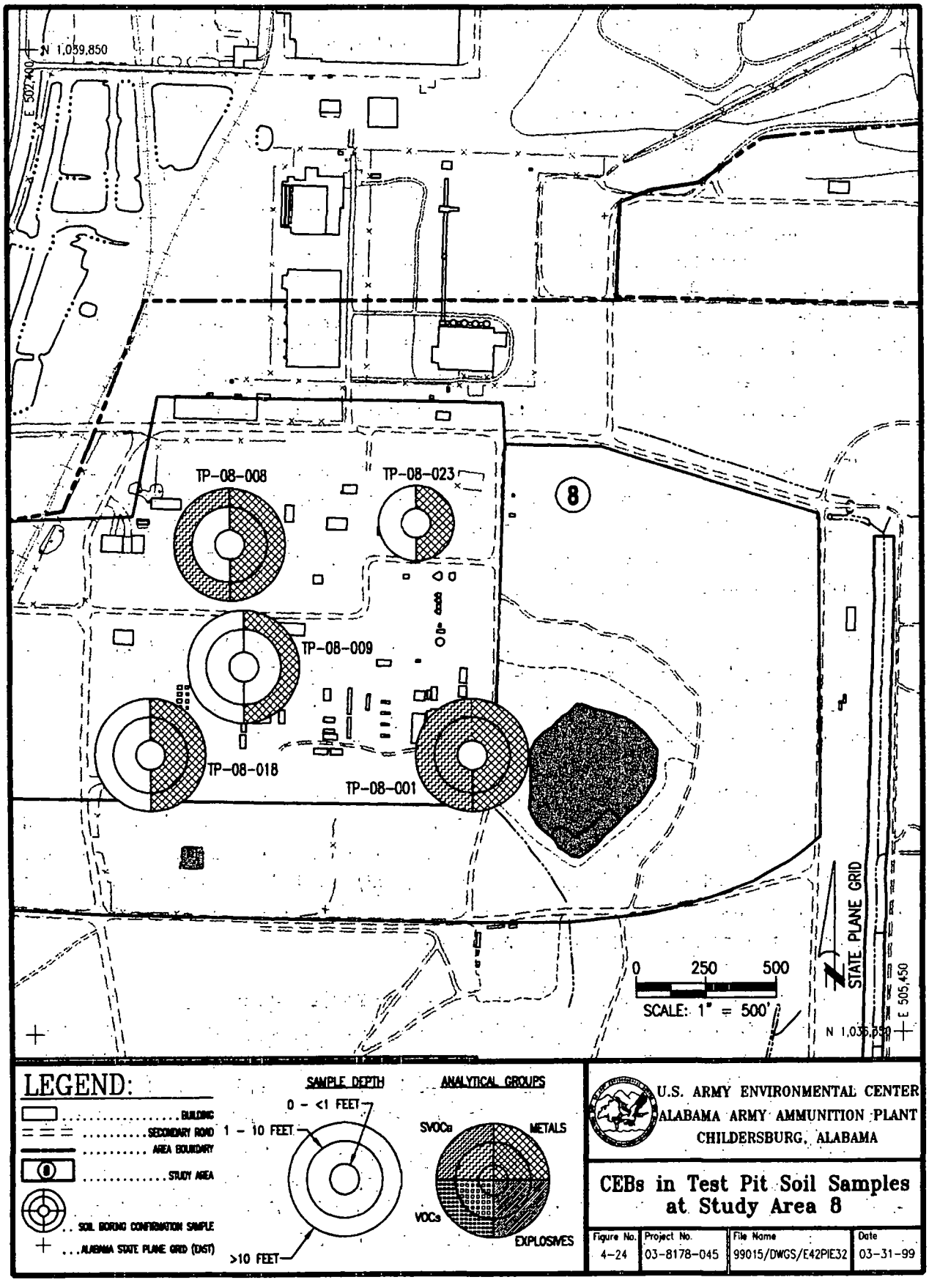
[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-35. Summary Statistics and Exposure Point Concentrations for Soil (>10 ft BLS) at Study Area 8 Test Pits - Acid/Organic Manufacturing Area
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:32:05 PM
Run Date: 3/29/99
Exposure Unit: 08_SD2

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	5 / 5	5 / 5	100%	--	--	19,000	35,900	25,600	6,883	Normal	32,162	32,162		27,567	[CEB][ANOVA]
Antimony	µg/g	5 / 5	5 / 5	100%	--	--	39	57	48	7.3	Normal	55	55		--	[CEB]
Arsenic	µg/g	5 / 5	5 / 5	100%	--	--	16	25	18	3.8	Lognormal	23	23		52	[bk]
Barium	µg/g	5 / 5	5 / 5	100%	--	--	25	67	47	18	Normal	64	64		41	[CEB][ANOVA]
Calcium	µg/g	5 / 5	5 / 5	100%	--	--	248	1,160	536	375	Normal	894	894		257	[CEB]
Chromium	µg/g	5 / 5	5 / 5	100%	--	--	35	60	46	11	Normal	56	56		53	[CEB][ANOVA]
Cobalt	µg/g	2 / 5	2 / 5	40%	2.5	2.5	3.5	7.5	3.0	2.7	Lognormal	17	7.5	#	58	[bk]
Copper	µg/g	5 / 5	5 / 5	100%	--	--	15	30	19	6.3	Normal	25	25		56	[bk]
Iron	µg/g	5 / 5	5 / 5	100%	--	--	46,000	320,000	119,360	114,240	Lognormal	571,461	320,000	#	57,000	[CEB]
Lead	µg/g	5 / 5	5 / 5	100%	--	--	12	23	20	4.9	Lognormal	29	23	#	32	[bk]
Magnesium	µg/g	5 / 5	5 / 5	100%	--	--	489	734	604	107	Normal	707	707		867	[bk]
Manganese	µg/g	5 / 5	5 / 5	100%	--	--	170	818	364	276	Normal	627	627		1,331	[bk]
Nickel	µg/g	5 / 5	5 / 5	100%	--	--	7.6	15	11	3.5	Normal	14	14		46	[bk]
Potassium	µg/g	5 / 5	5 / 5	100%	--	--	412	1,130	834	274	Normal	1,095	1,095		1,206	[bk]
Sodium	µg/g	1 / 5	1 / 5	20%	39	39	1,080	1,080	231	474	Lognormal	444,022	1,080	#	--	[CEB]
Vanadium	µg/g	5 / 5	5 / 5	100%	--	--	50	101	77	19	Normal	95	95		92	[CEB][ANOVA]
Zinc	µg/g	5 / 5	5 / 5	100%	--	--	32	46	39	5.7	Normal	44	44		104	[bk]
Phenol	µg/g	2 / 5	2 / 5	40%	0.052	0.052	0.12	0.16	0.072	0.064	Normal	0.13	0.13		--	[CEB]
pH	µg/g	5 / 5	5 / 5	100%	--	--	5.2	7.5	5.9	1.1	Normal	6.9	6.9		--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)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E 502,400
TP-08-008
TP-08-023
8
TP-08-009
TP-08-018
TP-08-001
0 250 500
SCALE: 1" = 500'
STATE PLANE GRID
E 505,450
N 1,036,850
LEGEND:
BUILDING
SECONDARY ROAD
AREA BOUNDARY
STUDY AREA
SOIL BORING CONFIRMATION SAMPLE
ALABAMA STATE PLANE GRID (DIST)
SAMPLE DEPTH
0 - <1 FEET
1 - 10 FEET
>10 FEET
ANALYTICAL GROUPS
SVOCs
METALS
VOCs
EXPLOSIVES
U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA
CEBs in Test Pit Soil Samples at Study Area 8
Figure No. 4-24
Project No. 03-8178-045
File Name 99015/DWGS/E42PIE32
Date 03-31-99

Metals—Eleven metals were detected in the Study Area 8 test pit soil samples at concentrations exceeding background. The metals and their maximum concentrations in each soil interval where concentrations exceeded background are listed in the adjacent box.

Maximum Concentrations*			
Analyte (µg/g)	0-<1ft	1-10ft	>10ft
Aluminum			35,900
Antimony		**69.5**	**57.4**
Arsenic		60	66.8
Barium		195	66.8
Calcium			**1,160**
Chromium		67.8	60.2
Copper		26.2	
Iron		320,000	**320,000**
Lead		**167**	
Sodium			**1,080**
Vanadium		124	101

* Metals also determined to exceed background based on ANOVA evaluation are shown in bold.

Antimony concentrations decreased with depth at all sample locations except in TP-08-023, where antimony was not detected in the shallower test pit sample at 5 feet BLS. The concentration in the 8-foot BLS sample at this location was 52.1 µg/g. The maximum detected antimony concentration (69.5 µg/g) in the test pit samples was the highest detected concentration in any of the shallow subsurface Supplemental RI soil samples.

There was no pattern to the distribution of iron in the test pit samples. Maximum concentrations of 320,000 µg/g were detected in the 10.5-foot BLS sample at TP-08-009 and 9-foot BLS sample at TP-08-018. All other concentrations of iron were less than 100,000 µg/g. The maximum lead concentration of 167 µg/g was detected in the 5-foot BLS sample at TP-08-023. All other lead concentrations were below 26 µg/g.

SVOCs—Only one SVOC, phenol, was detected in the Study Area 8 test pit soil samples. Phenol was detected in one shallow subsurface sample (TP-08-001 at 10 feet BLS) at a concentration of 0.110 µg/g and in two deep subsurface samples (TP-08-001 at 12 feet BLS and TP-08-008 at 12 feet BLS) at a maximum concentration of 0.160 µg/g.

pH—The pH range for samples collected from the Study Area 8 test pit soils was 5.26 to 7.52. pH results were very similar for samples from the same test pits, with the exception of TP-08-018. The pH in this test pit was lower than neutral in the 9-foot BLS sample (5.88) and slightly higher than neutral in the 11-foot BLS sample (7.52). With the exception of the 11-foot BLS sample at TP-08-018, all pH results were slightly acidic. These pH results are within the range of soil pH results from samples collected throughout Area B.

Summary—The Study Area 8 test pit samples were analyzed for metals, SVOCs, and pH. Metals and one SVOC (phenol) were detected in the Study Area 8 test pit soil samples. Eleven metals were identified as CEBs in the test pit samples. With the exception of aluminum, concentrations of CEB metals generally were lower in the deeper subsurface samples than in the shallower subsurface samples. Antimony concentrations in the test pit samples were the highest of any of the shallow subsurface Supplemental RI soil samples. Phenol was detected in three samples at concentrations ≤0.160 µg/g. The pH for the majority of samples from the Study Area 8 test pits was slightly acidic (5.26 to 6.52), with only one sample with a pH >7 (7.52). These pH results are within the range of soil pH results from samples collected throughout Area B.

4.5.9 Study Area 10 – Tetryl Manufacturing Area

The Tetryl Manufacturing Area consisted of 12 manufacturing lines where tetryl was produced in a two-step process by first sulfonating N-N-dimethylaniline and then nitrating the resulting intermediate. Extensive amounts of lead were used in the piping, floors, and fittings of the nitration houses. The buildings have been razed and all that remains of each line are the concrete foundations of the buildings. During a previous investigation, explosives material was recovered from the soil surface (DA 1978), and tetryl, lead, and DPA were detected in the soil.

SAIC's Supplemental RI at Study Area 10 was limited to the eastern half of the study area. Soil results for the sampling conducted at Study Area 10–East and Study Area 10–West are presented below. Investigations conducted in 1995 by Roy F. Weston in the western half of the study area confirmed that the soils contained significant tetryl contamination in the vicinity of the tetryl production lines, nitrating houses, and recovery houses. Excavation of those soils was conducted in September through December 1995.

4.5.9.1 Study Area 10–East

Surface sampling locations at Study Area 10–East were selected to determine if contamination extended into the eastern portion of the Tetryl Manufacturing Area. Forty-six surface soil sampling locations were established during Phase 1 of the Supplemental RI. A sample from each of the 46 surface soil sampling locations was screened for explosives in the field laboratory. To confirm the screening results, five samples were selected from the screening locations. These samples were sent to an offsite laboratory for analysis. In addition, six soil borings were drilled, three in the western portion of Study Area 10–East to determine the presence and extent of subsurface soil contamination between the tetryl production lines, and three in the eastern portion of Study Area 10–East. Thirty-four subsurface soil samples were collected from the borings and screened for explosives in the field laboratory. Seven shallow subsurface soil samples and 11 deep subsurface soil samples were collected from the borings and submitted for confirmatory analysis. Confirmatory samples were analyzed for metals, explosives, SVOCs, and VOCs.

Appendix K presents the data summary tables for Study Area 10–East. **Tables 4-36** through **4-38** present summary statistics for Study Area 10–East soils. **Figure 4-25** shows the locations where the general contaminant group CEBs (metals, explosives, VOCs, and SVOCs) were detected in Study Area 10–East soils. A lack of quadrants in a circle indicates a sample was not collected in that interval. Sheets 4-5 and 4-6 present screening results for surface and subsurface soils, respectively, at Study Area 10–East.

Table 4-36. Summary Statistics and Exposure Point Concentrations for Soil (0-<1 ft BLS) at Study Area 10 - Tetryl Manufacturing Area-East
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:44:26 PM
Run Date: 3/29/99
Exposure Unit: 10E_SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	4 / 4	4 / 4	100%	--	--	12,000	15,000	13,500	1,291	Normal	15,019	15,000	#	20,277	[bk]
Arsenic	µg/g	1 / 4	1 / 4	25%	13	13	19	19	9.4	6.2	Lognormal	32	19	#	15	[CEB][ANOVA]
Barium	µg/g	4 / 4	4 / 4	100%	--	--	76	233	117	77	Lognormal	406	233	#	124	[CEB][ANOVA]
Beryllium	µg/g	4 / 4	4 / 4	100%	--	--	0.40	0.95	0.58	0.25	Normal	0.88	0.88		0.82	[CEB][ANOVA]
Calcium	µg/g	4 / 4	4 / 4	100%	--	--	946	1,340	1,107	188	Normal	1,329	1,329		4,960	[bk]
Chromium	µg/g	2 / 4	2 / 4	50%	26	27	32	33	23	11	Normal	35	33	#	54	[bk]
Cobalt	µg/g	2 / 4	2 / 4	50%	2.5	2.5	5.5	9.2	4.3	3.8	Normal	8.8	8.8		14	[bk]
Copper	µg/g	4 / 4	4 / 4	100%	--	--	5.6	10	8.8	2.2	Lognormal	14	10	#	13	[bk]
Iron	µg/g	4 / 4	4 / 4	100%	--	--	24,000	38,000	31,500	5,745	Normal	38,260	38,000	#	37,560	[CEB][ANOVA]
Lead	µg/g	4 / 4	4 / 4	100%	--	--	22	37	29	7.3	Normal	37	37		34	[CEB]
Magnesium	µg/g	4 / 4	4 / 4	100%	--	--	262	474	390	93	Normal	500	474	#	1,189	[bk]
Manganese	µg/g	4 / 4	4 / 4	100%	--	--	870	4,100	1,893	1,486	Lognormal	11,637	4,100	#	1,730	[CEB][ANOVA]
Potassium	µg/g	4 / 4	4 / 4	100%	--	--	401	613	511	100	Normal	629	613	#	680	[bk]
Vanadium	µg/g	4 / 4	4 / 4	100%	--	--	43	72	59	14	Normal	75	72	#	76	[bk]
Zinc	µg/g	4 / 4	4 / 4	100%	--	--	24	32	29	3.6	Normal	33	32	#	36	[bk]
Benzoic Acid	µg/g	1 / 4	1 / 4	25%	0.92	0.92	13	13	3.6	6.3	Lognormal	170,006	13	#	--	[CEB]
Total Organic Carbon	µg/g	4 / 4	4 / 4	100%	--	--	21,000	37,300	31,200	7,731	Normal	40,297	37,300	#	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-37. Summary Statistics and Exposure Point Concentrations for Soil (1-10 ft BLS) at Study Area 10 - Tetryl Manufacturing Area-East
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:44:26 PM
Run Date: 3/29/99
Exposure Unit: 10E_SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	6 / 7	6 / 7	86%	540	540	13,000	25,000	15,324	7,738	Normal	21,007	21,007		27,733	[bk]
Arsenic	µg/g	4 / 7	4 / 7	57%	13	13	17	34	16	11	Normal	24	24		42	[bk]
Barium	µg/g	7 / 7	7 / 7	100%	--	--	18	73	48	22	Normal	65	65		64	[CEB][ANOVA]
Beryllium	µg/g	7 / 7	7 / 7	100%	--	--	0.39	1.0	0.57	0.23	Lognormal	0.79	0.79		0.80	[CEB][ANOVA]
Calcium	µg/g	4 / 7	4 / 7	57%	109	109	235	385	215	158	Normal	331	331		2,475	[bk]
Chromium	µg/g	7 / 7	7 / 7	100%	--	--	12	161	72	69	Normal	122	122		46	[CEB][ANOVA]
Cobalt	µg/g	5 / 7	5 / 7	71%	2.5	2.5	5.7	9.4	5.7	3.4	Normal	8.2	8.2		7.0	[CEB][ANOVA]
Copper	µg/g	7 / 7	7 / 7	100%	--	--	6.1	23	11	5.5	Lognormal	17	17		26	[bk]
Iron	µg/g	7 / 7	7 / 7	100%	--	--	16,000	77,000	31,286	20,934	Lognormal	52,660	52,660		52,000	[CEB][ANOVA]
Lead	µg/g	4 / 7	4 / 7	57%	10.0	10.0	13	32	14	10	Normal	21	21		14	[CEB][ANOVA]
Magnesium	µg/g	7 / 7	7 / 7	100%	--	--	308	1,100	586	255	Normal	774	774		1,399	[bk]
Manganese	µg/g	7 / 7	7 / 7	100%	--	--	104	1,400	596	409	Normal	897	897		682	[CEB][ANOVA]
Nickel	µg/g	3 / 7	3 / 7	43%	7.5	7.5	12	13	7.4	4.6	Lognormal	15	13	#	21	[bk]
Potassium	µg/g	7 / 7	7 / 7	100%	--	--	321	838	512	184	Normal	647	647		1,324	[bk]
Sodium	µg/g	2 / 7	2 / 7	29%	50	50	67	105	42	32	Lognormal	82	82		--	[CEB]
Vanadium	µg/g	7 / 7	7 / 7	100%	--	--	33	108	63	30	Normal	85	85		96	[CEB][ANOVA]
Zinc	µg/g	1 / 1	1 / 1	100%	--	--	36	36	--	--	Undetermined	--	36	#	71	[bk]
Acetone	µg/g	3 / 7	3 / 7	43%	0.045	0.045	0.021	0.032	0.024	0.0038	Lognormal	0.026	0.026		--	[CEB]
Toluene	µg/g	6 / 7	6 / 7	86%	0.0025	0.0025	0.0026	0.092	0.017	0.033	Lognormal	0.20	0.092	#	--	[CEB]
Total Organic Carbon	µg/g	6 / 7	6 / 7	86%	1000	1000	2,380	8,050	3,726	2,369	Normal	5,466	5,466		--	[CEB]

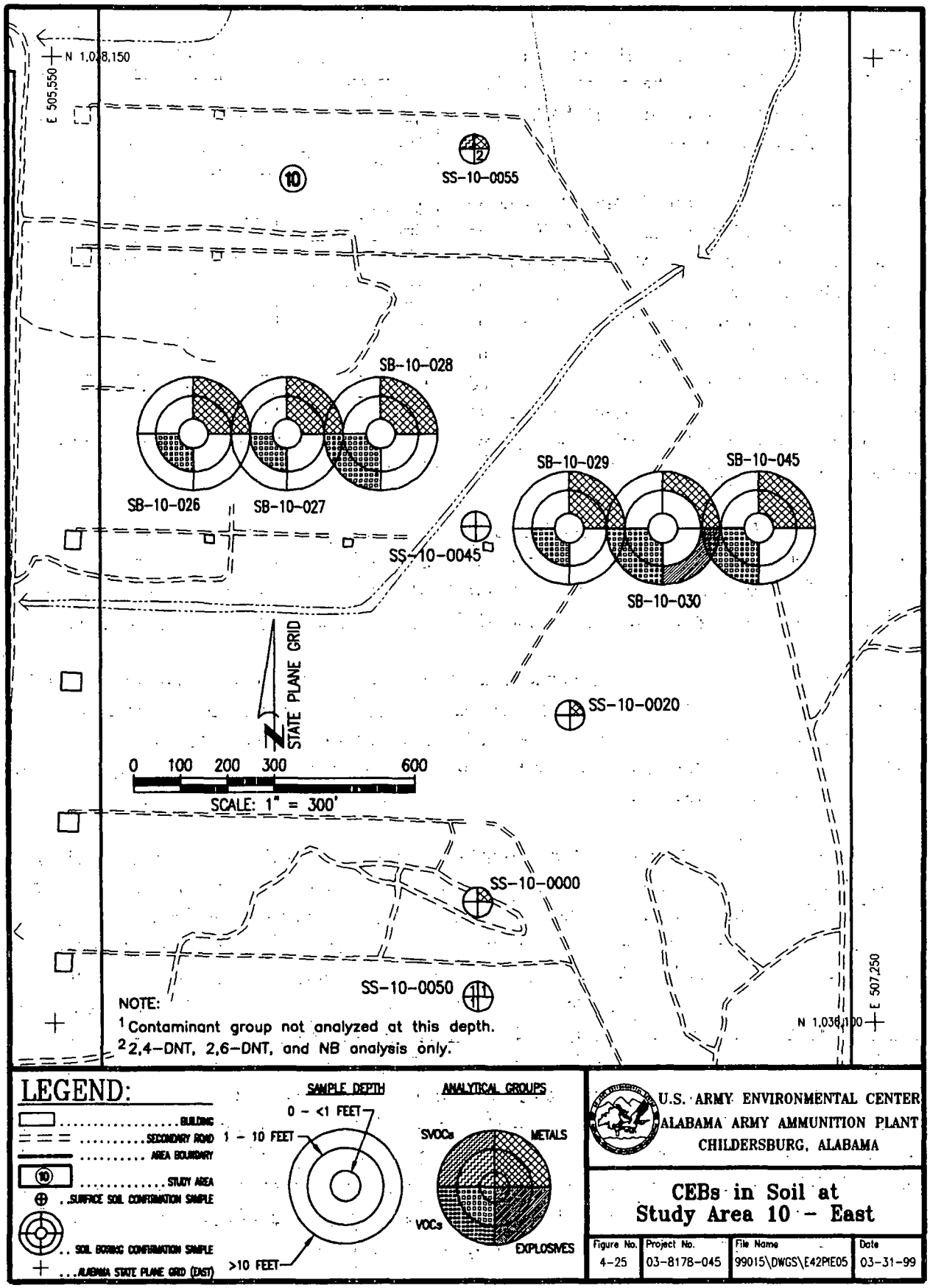
[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-38. Summary Statistics and Exposure Point Concentrations for Soil (>10 ft BLS) at Study Area 10 - Tetryl Manufacturing Area-East
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:44:26 PM
Run Date: 3/29/99
Exposure Unit: 10E_SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	11 / 11	11 / 11	100%	--	--	5,100	250,000	36,191	71,165	Lognormal	73,145	73,145		27,567	[CEB][ANOVA]
Arsenic	µg/g	4 / 11	4 / 11	36%	13	13	21	31	13	9.8	Lognormal	23	23		52	[bk]
Barium	µg/g	11 / 11	11 / 11	100%	--	--	13	132	47	38	Normal	68	68		41	[CEB][ANOVA]
Beryllium	µg/g	10 / 11	10 / 11	91%	0.25	0.25	0.43	2.7	1.2	0.75	Normal	1.6	1.6		0.89	[CEB][ANOVA]
Calcium	µg/g	7 / 11	7 / 11	64%	109	109	139	451	179	130	Normal	250	250		257	[CEB][ANOVA]
Chromium	µg/g	11 / 11	11 / 11	100%	--	--	11	56	23	12	Lognormal	31	31		53	[CEB][ANOVA]
Cobalt	µg/g	7 / 11	7 / 11	64%	2.5	2.5	4.9	43	10	13	Lognormal	46	43	#	58	[bk]
Copper	µg/g	11 / 11	11 / 11	100%	--	--	10	27	22	5.0	Normal	24	24		56	[bk]
Iron	µg/g	10 / 10	10 / 10	100%	--	--	22,000	54,000	43,900	8,888	Lognormal	52,101	52,101		57,000	[bk]
Lead	µg/g	8 / 11	8 / 11	73%	10.0	10.0	14	120	36	35	Lognormal	127	120	#	32	[CEB][ANOVA]
Magnesium	µg/g	11 / 11	11 / 11	100%	--	--	299	944	558	193	Normal	664	664		867	[CEB][ANOVA]
Manganese	µg/g	11 / 11	11 / 11	100%	--	--	42	5,800	1,472	1,767	Lognormal	17,835	5,800	#	1,331	[CEB][ANOVA]
Nickel	µg/g	8 / 11	8 / 11	73%	7.5	7.5	15	47	24	16	Normal	33	33		46	[CEB][ANOVA]
Potassium	µg/g	11 / 11	11 / 11	100%	--	--	420	1,810	894	414	Normal	1,120	1,120		1,206	[CEB][ANOVA]
Sodium	µg/g	5 / 11	5 / 11	45%	50	50	67	99	53	33	Lognormal	88	88		--	[CEB]
Vanadium	µg/g	11 / 11	11 / 11	100%	--	--	31	89	61	20	Normal	71	71		92	[bk]
Zinc	µg/g	6 / 6	6 / 6	100%	--	--	24	92	54	28	Normal	76	76		104	[bk]
Acetone	µg/g	5 / 11	5 / 11	45%	0.035	0.057	0.032	0.041	0.029	0.0079	Normal	0.033	0.033		--	[CEB]
Cyclotetramethylenetetranitramine	µg/g	1 / 11	1 / 11	9%	0.16	0.16	0.23	0.23	0.093	0.044	Lognormal	0.11	0.11		--	[CEB]
Methylene Chloride	µg/g	2 / 11	2 / 11	18%	0.0062	0.0062	0.0079	0.0099	0.0042	0.0024	Lognormal	0.0054	0.0054		--	[CEB]
Toluene	µg/g	4 / 11	4 / 11	36%	0.0018	0.0030	0.0022	0.0053	0.0020	0.0014	Lognormal	0.0031	0.0031		--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)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10
SS-10-0055
SB-10-028
SB-10-026
SB-10-027
SB-10-029
SB-10-045
SB-10-030
SS-10-0045
SS-10-0020
STATE PLANE GRID
0 100 200 300 600
SCALE: 1" = 300'
SS-10-0000
SS-10-0050
NOTE:
1 Contaminant group not analyzed at this depth.
2 2,4-DNT, 2,6-DNT, and NB analysis only.
E 507,250
N 1,036,100
LEGEND:
BUILDING
SECONDARY ROAD
AREA BOUNDARY
STUDY AREA
SURFACE SOIL CONFIRMATION SAMPLE
SOIL BORING CONFIRMATION SAMPLE
ALABAMA STATE PLANE GRID (EAST)
SAMPLE DEPTH
0 - <1 FEET
1 - 10 FEET
>10 FEET
ANALYTICAL GROUPS
SVOCs
METALS
VOCs
EXPLOSIVES
U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA
CEBs in Soil at
Study Area 10 - East
Figure No. 4-25
Project No. 03-8178-045
File Name 99015\DWGS\E42PIE05
Date 03-31-99

Metals—Fifteen metals were detected in Study Area 10–East soils at concentrations exceeding background. The metals and their maximum concentrations exceeding background are listed in the adjacent box.

Maximum Concentrations*			
Analyte (µg/g)	**0-<1ft**	**1-10ft**	**>10ft**
Aluminum			250,000
Arsenic	18.7		
Barium	233	72.5	132
Beryllium	0.948	1.03	2.66
Calcium			451
Chromium		161	56.1
Cobalt		9.38	
Iron	38,000	77,000	
Lead	**37.4**	31.6	120
Magnesium			944
Manganese	4,100	1,400	5,800
Nickel			47.3
Potassium			1,810
Sodium		**105**	**98.9**
Vanadium		108	

* Metals also determined to exceed background based on ANOVA evaluation are shown in bold.

Metal CEBs were randomly distributed in the surface soils, although no metal CEBs were detected in surface soil samples SS-10-0045 or SS-10-0050. Lead concentrations in surface soils were all between 20 and 38 µg/g, and only exceeded background at SS-10-0055, in the northern portion of Study Area 10–East. Lead concentrations in the deep subsurface soil samples were higher than in the surface or shallow subsurface soil samples.

In the shallow and deep subsurface soils, there were more metal CEBs in the western portion of Study Area 10–East than in the eastern portion of the study area. Maximum detected deep subsurface soil concentrations of aluminum (250,000 µg/g) and manganese (5,800 µg/g) at Study Area 10–East were high relative to other study areas sampled during the Supplemental RI.

Explosives—Field screening data consistently showed that explosives contamination of the surface soils is not present at Study Area 10. Of the 46 surface soil samples screened in the field for explosives, only two samples, SS-10-1000 (the extreme southeastern sampling point) and SS-10-0580 (located in the center of the eastern site boundary), contained detectable concentrations of explosives (4.0 µg/g) (Sheet 4-5).

Explosives were detected in five subsurface samples collected from three of the six soil borings screened for explosives. The three soil borings in which explosives were detected were located in the western portion of the study area, in the vicinity of the former tetryl lines. Specifically, explosives were detected in a sample collected at a depth of 15 feet from the far western soil boring (SB-10-026); in samples collected at depths of 5, 10, and 15 feet from SB-10-027; and in a sample collected from a depth of 25 feet from SB-10-028 (Sheet 4-6). Concentrations of explosives in all subsurface soil samples screened in the field were less than 6 µg/g. All but one of the subsurface samples in which explosives were detected were submitted for confirmatory analysis; target explosives were not detected in any of these samples, nor were target explosives detected in any other surface and subsurface samples submitted for fixed laboratory analysis. One nontarget explosive (HMX) was detected in one deep subsurface soil sample (SB-10-030; 15 feet BLS) at a concentration of 0.225 µg/g. HMX was not detected in the 25-foot BLS sample collected from SB-10-030. The screening and confirmatory results indicate that there are only very low concentrations of residual explosives in soils at Study Area 10–East.

VOCs—Three VOCs were detected in Study Area 10 soils. The VOCs and their maximum concentrations in each soil interval are listed in the adjacent box.

Maximum Concentrations			
Analyte (µg/g)	0-<1ft	1-10ft	>10ft
Acetone		0.032	0.041
Methylene Chloride			0.0099
Toluene		0.092	0.0053

The majority of concentrations of acetone, methylene chloride, and toluene from surface and subsurface soils were near or below CRLs (0.0446, 0.00616, and 0.0025 µg/g, respectively). Toluene was detected at a concentration of 0.092 µg/g in the 1-foot BLS sample at SB-10-029, but was not detected in the deeper samples collected from this boring.

SVOCs—Only one SVOC, benzoic acid, was detected in the Study Area 10–East soil samples. Benzoic acid was detected at a concentration of 13 µg/g in surface soil sample SS-10-0055.

Summary—Metals, one nontarget explosive (HMX), VOCs, and one SVOC (benzoic acid) were detected in the soils at Study Area 10–East. Fifteen metals exceeded background, and aluminum and manganese concentrations were among the highest detected during the Supplemental RI. All lead concentrations were below 121 µg/g. There were more frequent detections of CEB metals in the western portion of the study area than in the eastern portion. Explosives screening results from surface and subsurface soils all were less than 6 µg/g. Target explosives were not detected in confirmatory samples from the Study Area 10–East surface or subsurface soils. The majority of VOCs detected in the Study Area 10–East soils were at concentrations at or near CRLs. The concentrations are not believed to be attributable to site activities. Benzoic acid was the only SVOC detected in Study Area 10–East soils and it was detected in only one surface soil sample.

4.5.9.2 Study Area 10–West

Roy F. Weston conducted investigations, excavation, and remediation of Study Area 10–West soils as a result of a 1994 Interim Record of Decision (IROD) (Weston 1994a). Roy F. Weston found that samples collected at the concrete pads of nitrating houses, refinery houses, and open ditches were highly contaminated with tetryl. The excavation criterion for tetryl established in the IROD was 5,000 ppm (Weston 1996a). A few samples also contained lead in excess of the excavation criterion (500 ppm) (Weston 1996a). Approximately 13,034 cubic yards of soils were removed from around the tetryl lines.

Explosives-contaminated soils were incinerated and the ash was landfilled. Lead-contaminated soils and ash were stabilized and landfilled.

Composite confirmatory samples were collected after excavations for explosives and lead. Appendix L presents the Roy F. Weston data summary tables for the confirmatory samples collected from Study Area 10–West. **Tables 4-39** and **4-40** present summary statistics for Study Area 10–West soils.

Table 4-39. Summary Statistics and Exposure Point Concentrations for Soil (0-<1 ft BLS) at Study Area 10 - Tetryl Manufacturing Area-West Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:46:35 PM
Run Date: 3/29/99
Exposure Unit: 10W_SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]	2 x BK Mean[g]	Background Comparison[g]
Lead	µg/g	49 / 49	49 / 49	100%	--	--	6.4	2,000	259	531	Lognormal	465	465	34	[CEB][ANOVA]
2,4-Dinitrotoluene	µg/g	1 / 57	1 / 57	2%	0.50	0.50	0.79	0.79	0.26	0.072	Lognormal	0.27	0.27	--	[CEB]
2-Amino-4,6-Dinitrotoluene	µg/g	2 / 57	2 / 57	4%	0.50	0.50	0.50	0.70	0.26	0.068	Lognormal	0.27	0.27	--	[CEB]
Tetryl	µg/g	5 / 57	5 / 57	9%	0.50	0.50	0.92	112	3.1	16	Lognormal	0.86	0.86	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-40. Summary Statistics and Exposure Point Concentrations for Soil (1-10 ft BLS) at Study Area 10 - Tetryl Manufacturing Area-West Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:46:35 PM
Run Date: 3/29/99
Exposure Unit: 10W_SSI

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]	2 x BK Mean[d]	Background Comparison[g]
Lead	µg/g	103 / 103	103 / 103	100%	--	--	8.0	400	62	72	Lognormal	73	73	14	[CEB]
1,3,5-Trinitrobenzene	µg/g	3 / 82	3 / 82	4%	0.23	0.50	0.24	1.8	0.26	0.19	Lognormal	0.27	0.27	--	[CEB]
2,4,6-Trinitrotoluene	µg/g	1 / 82	1 / 82	1%	0.23	0.50	0.86	0.86	0.24	0.082	Lognormal	0.25	0.25	--	[CEB]
Tetryl	µg/g	54 / 96	54 / 96	56%	0.50	0.74	0.50	2,939	80	341	Lognormal	187	187	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Metals—Lead was detected in all 49 surface soil and 103 shallow subsurface soil confirmatory samples collected. Lead exceeded background in 11 surface soil and the majority of shallow subsurface soil samples. The maximum detected lead concentration in surface soil confirmatory samples was 2,000 µg/g. Ten surface soil samples contained lead concentrations in excess of 500 ppm. All shallow subsurface soil lead concentrations were below 500 ppm; the maximum lead in shallow subsurface soil was 400 ppm.

Explosives—Five explosives were detected in the excavation confirmatory samples collected from Study Area 10–West. Explosives were detected in 7 of 57 surface soil confirmatory samples. All surface soil explosives concentrations were below 2 µg/g, with the exception of two samples with tetryl concentrations of 47 and 112 µg/g. 1,3,5-TNB was detected in 3 of 82 shallow subsurface soil samples at a maximum concentration less than 2 µg/g. TNT was detected in 1 of 82 shallow subsurface soil samples. Tetryl was detected in 54 of 96 shallow subsurface soil samples, with all concentrations except the maximum less than 1,250 µg/g.

Maximum Concentrations			
Analyte (µg/g)	0-<1ft	1-10ft	>10ft
2,4-DNT	0.79		
2-A-4,6-DNT	0.70		
Tetryl	112	2,939	
1,3,5-TNB		1.8	
TNT		0.86	

Summary—Roy F. Weston excavated, remediated, and incinerated tetryl- and lead-contaminated soils from around the tetryl lines at Study Area 10–West. Lead-contaminated soils and ash were stabilized. Confirmatory samples were collected after excavation and analyzed for explosives and lead. Confirmatory sample results indicate that all lead concentrations, with the exception of 10 surface soil samples, were below 500 ppm. All explosives concentrations, other than for tetryl, were below 2 µg/g. All tetryl concentrations, with the exception of one sample, were below 1,250 µg/g.

4.5.10 Study Area 16 – Flashing Ground

The Flashing Ground consists of four trenches (Burning Pits 1 through 4) that were used after World War II. According to the Installation Assessment, combustible trash and explosives materials were burned in this area (DA 1978). Previous studies revealed the presence of lead, nitrocellulose, TNT, DNT, 1,3,5-TNB, and tetryl in soils (ESE 1983).

Fifty-two soil sampling locations were established at Study Area 16 during Phase 1 of the Supplemental RI. Surface soil samples from 44 of the locations and shallow subsurface samples (2 feet BLS) from 8 of the locations were screened for explosives in the field laboratory (Sheets 4-5 and 4-6). Surface samples at 38 of the 52 soil sampling locations (30 surface and 8 shallow subsurface [2 feet BLS] sampling locations) were screened for lead on a quick-turnaround basis in the offsite laboratory (Sheets 4-5 and 4-6). Samples were collected from 3 of the 44 surface soil sampling locations and were submitted for confirmatory analysis of metals, SVOCs, VOCs, and explosives.

Eight soil borings were drilled at Study Area 16. Thirty-three samples from the five borings were screened in the field for explosives. Twenty-three shallow subsurface and nine deep subsurface samples were collected from the soil borings and submitted for laboratory analysis. All 32 subsurface samples collected from soil borings were analyzed for lead on a quick-turnaround basis. Thirteen subsurface samples were analyzed for metals, explosives, VOCs, and SVOCs. During Phase 2, seven borings were drilled to collect screening soil and in situ groundwater samples. A soil sample was not collected from three of the borings because rock was encountered. One sample was collected from each of four borings (SB-16-001, SB-16-003, SB-16-006, and SB-16-007) and analyzed at the laboratory for explosives and lead. Two additional samples were collected from surface soil location SS-16-7030 and analyzed for aluminum and lead.

Explosives- and lead-contaminated soils at Study Area 16 detected during the Supplemental RI (SAIC 1996a) were included for remediation in a 1996 IROD (Weston 1996b, 1996c). Roy F. Weston conducted a sampling program to quantify the extent of explosives and lead contamination identified by SAIC in 1996 (SAIC 1996a). Screening and confirmatory samples were collected at five locations within Study Area 16 and adjacent Study Area 19. Study Area 16 soils in the general areas of Burning Pits 2 and 3 were identified for remediation. The maximum TNT and 2,4-DNT concentrations detected at Study Area 16 were 14,000 and 16,000 ppm, respectively. In addition, one of five confirmatory soil samples contained a lead concentration of 628 ppm (Weston 1996b, 1996c). All soils with explosives and lead above applicable criteria were excavated, transported, and incinerated. Incinerator ash with high lead concentrations was stockpiled for future solidification and stabilization. Soils in grid areas with lead contamination only were temporarily left in place.

Subsequent to Roy F. Weston's remediation, Environmental Chemical Corporation (ECC) conducted additional remediation for lead-contaminated soils at Study Area 16. All lead-contaminated soils with concentrations in excess of 300 ppm were excavated and stabilized using an onsite pugmill. Confirmatory samples were collected from the excavation. **Figure 4-26** shows the area of Study Area 16 soils excavated by ECC. The remaining stockpiled incinerator ash with high lead concentrations also was stabilized (ECC 1998). A total of 1,500 cubic yards of lead-contaminated soil from Study Areas 16 and 19 were excavated and stabilized.

Appendix K presents the SAIC Supplemental RI data summary tables for Study Area 16. Appendix L contains the remediation data summary tables for samples collected by Roy F. Weston and ECC. For the purposes of statistical analysis, Supplemental RI data from locations that subsequently were remediated were removed from the data set. The post-excavation confirmatory data were included in the statistical analysis. Summary statistics for the soils remaining at Study Area 16 are shown in **Tables 4-41** through **4-43**. **Figure 4-27** shows the locations where the general contaminant group CEBs (metals, SVOCs, VOCs, and explosives) were detected in Supplemental RI samples in Study Area 16 soils remaining after remediation. The lack of quadrants in a circle indicates that a soil sample was not collected at that interval. Sheets 4-5 and 4-6 depict screening results for surface and subsurface samples collected from Study Area 16.

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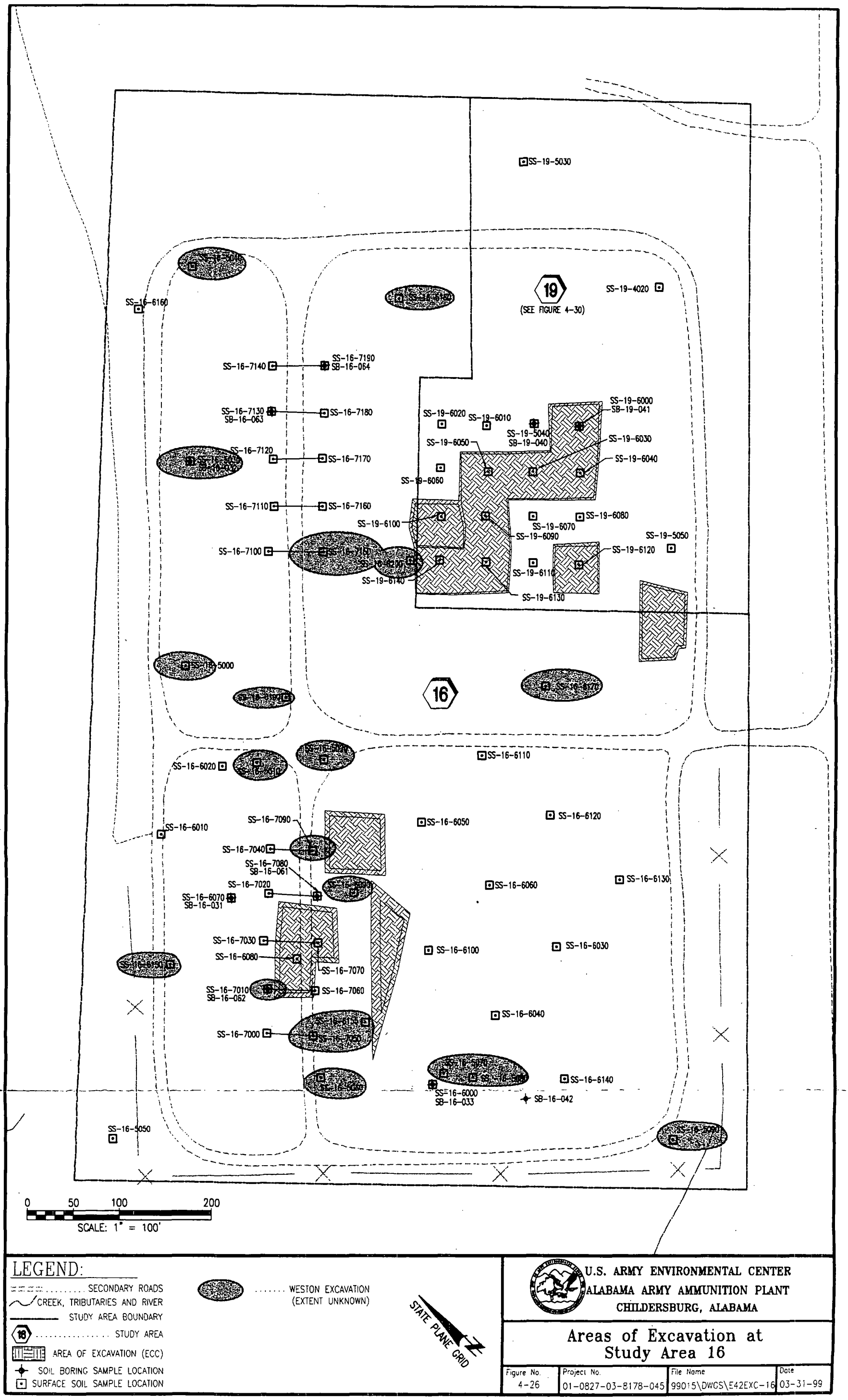
SS-19-5030
19
(SEE FIGURE 4-30)
SS-19-4020
SS-16-6160
SS-16-7140
SS-16-7190
SB-16-064
SS-16-7130
SB-16-063
SS-16-7180
SS-16-7120
SS-16-7170
SS-16-7110
SS-16-7160
SS-16-7100
SS-19-6020
SS-19-6010
SS-19-6000
SB-19-041
SS-19-5040
SB-19-040
SS-19-6050
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SS-16-7010
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SS-16-6100
SS-16-6030
SS-16-6040
SS-16-7000
SS-16-6140
SS-16-6000
SB-16-033
SB-16-042
SS-16-5050
0 50 100 200
SCALE: 1" = 100'
LEGEND:
SECONDARY ROADS
CREEK, TRIBUTARIES AND RIVER
STUDY AREA BOUNDARY
STUDY AREA
AREA OF EXCAVATION (ECC)
SOIL BORING SAMPLE LOCATION
SURFACE SOIL SAMPLE LOCATION
WESTON EXCAVATION
(EXTENT UNKNOWN)
STATE PLANE GRID
U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA
Areas of Excavation at
Study Area 16
Figure No.
4-26
Project No.
01-0827-03-8178-045
File Name
99015\DWGS\E42EXC-16
Date
03-31-99

Table 4-41. Summary Statistics and Exposure Point Concentrations for Soil (0-<1 ft BLS) at Study Area 16 - Flashing Ground
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 11:59:57 AM
Run Date: 3/31/99
Exposure Unit: 16_SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[g]	Background Comparison[h]
Aluminum	µg/g	5 / 5	3 / 3	100%	--	--	7,600	24,000	--	--	Undetermined	--	24,000	#	20,277	[CEB]
Arsenic	µg/g	1 / 3	1 / 3	33%	13	13	27	27	--	--	Undetermined	--	27	#	15	[CEB]
Barium	µg/g	3 / 3	3 / 3	100%	--	--	64	463	--	--	Undetermined	--	463	#	124	[CEB]
Beryllium	µg/g	3 / 3	3 / 3	100%	--	--	0.45	0.73	--	--	Undetermined	--	0.73	#	0.82	[bk]
Cadmium	µg/g	1 / 3	1 / 3	33%	0.43	0.43	32	32	--	--	Undetermined	--	32	#	--	[CEB]
Calcium	µg/g	3 / 3	3 / 3	100%	--	--	571	4,690	--	--	Undetermined	--	4,690	#	4,960	[bk]
Chromium	µg/g	2 / 3	2 / 3	67%	77	77	17	20	--	--	Undetermined	--	20	#	54	[bk]
Cobalt	µg/g	3 / 3	3 / 3	100%	--	--	4.2	25	--	--	Undetermined	--	25	#	14	[CEB]
Copper	µg/g	3 / 3	3 / 3	100%	--	--	9.8	1,600	--	--	Undetermined	--	1,600	#	13	[CEB]
Iron	µg/g	3 / 3	3 / 3	100%	--	--	8,400	51,000	--	--	Undetermined	--	51,000	#	37,560	[CEB]
Lead	µg/g	21 / 23	19 / 21	90%	10.0	10.0	13	5,400	470	1,208	Lognormal	2,017	2,017		34	[CEB]
Magnesium	µg/g	3 / 3	3 / 3	100%	--	--	335	7,200	--	--	Undetermined	--	7,200	#	1,189	[CEB]
Manganese	µg/g	3 / 3	3 / 3	100%	--	--	42	420	--	--	Undetermined	--	420	#	1,730	[bk]
Mercury	µg/g	1 / 3	1 / 3	33%	0.087	0.087	1.5	1.5	--	--	Undetermined	--	1.5	#	0.056	[CEB]
Nickel	µg/g	2 / 3	2 / 3	67%	7.5	7.5	9.1	71	--	--	Undetermined	--	71	#	9.4	[CEB]
Potassium	µg/g	3 / 3	3 / 3	100%	--	--	277	1,190	--	--	Undetermined	--	1,190	#	680	[CEB]
Sodium	µg/g	3 / 3	3 / 3	100%	--	--	66	212	--	--	Undetermined	--	212	#	501	[bk]
Vanadium	µg/g	3 / 3	3 / 3	100%	--	--	21	78	--	--	Undetermined	--	78	#	76	[CEB]
Zinc	µg/g	2 / 3	2 / 3	67%	17,000	17,000	147	180	--	--	Undetermined	--	180	#	36	[CEB]
2-Methylnaphthalene	µg/g	1 / 1	1 / 1	100%	--	--	0.24	0.24	--	--	Undetermined	--	0.24	#	--	[CEB]
Acenaphthene	µg/g	1 / 1	1 / 1	100%	--	--	0.39	0.39	--	--	Undetermined	--	0.39	#	--	[CEB]
Anthracene	µg/g	1 / 1	1 / 1	100%	--	--	0.93	0.93	--	--	Undetermined	--	0.93	#	--	[CEB]
Benzo(a)anthracene	µg/g	1 / 1	1 / 1	100%	--	--	2.6	2.6	--	--	Undetermined	--	2.6	#	--	[CEB]
Benzo(a)pyrene	µg/g	1 / 1	1 / 1	100%	--	--	2.8	2.8	--	--	Undetermined	--	2.8	#	--	[CEB]
Benzo(b)fluoranthene	µg/g	1 / 1	1 / 1	100%	--	--	4.4	4.4	--	--	Undetermined	--	4.4	#	--	[CEB]
Benzo(g,h,i)perylene	µg/g	1 / 1	1 / 1	100%	--	--	1.4	1.4	--	--	Undetermined	--	1.4	#	--	[CEB]
Benzo(k)fluoranthene	µg/g	1 / 1	1 / 1	100%	--	--	1.6	1.6	--	--	Undetermined	--	1.6	#	--	[CEB]
Chrysene	µg/g	1 / 1	1 / 1	100%	--	--	3.0	3.0	--	--	Undetermined	--	3.0	#	--	[CEB]
Dibenzo(a,h)anthracene	µg/g	1 / 1	1 / 1	100%	--	--	0.38	0.38	--	--	Undetermined	--	0.38	#	--	[CEB]
Dibenzofuran	µg/g	1 / 1	1 / 1	100%	--	--	0.21	0.21	--	--	Undetermined	--	0.21	#	--	[CEB]
Fluoranthene	µg/g	1 / 1	1 / 1	100%	--	--	5.6	5.6	--	--	Undetermined	--	5.6	#	--	[CEB]
Fluorene	µg/g	1 / 1	1 / 1	100%	--	--	0.36	0.36	--	--	Undetermined	--	0.36	#	--	[CEB]
Indeno(1,2,3-cd)pyrene	µg/g	1 / 1	1 / 1	100%	--	--	1.4	1.4	--	--	Undetermined	--	1.4	#	--	[CEB]
Methylene Chloride	µg/g	1 / 4	1 / 4	25%	0.0062	0.0062	0.0079	0.0079	0.0043	0.0024	Lognormal	0.011	0.0079	#	--	[CEB]
Naphthalene	µg/g	1 / 1	1 / 1	100%	--	--	0.13	0.13	--	--	Undetermined	--	0.13	#	--	[CEB]
Phenanthrene	µg/g	1 / 1	1 / 1	100%	--	--	3.4	3.4	--	--	Undetermined	--	3.4	#	--	[CEB]
Pyrene	µg/g	1 / 1	1 / 1	100%	--	--	5.8	5.8	--	--	Undetermined	--	5.8	#	--	[CEB]
Toluene	µg/g	1 / 4	1 / 4	25%	0.0025	0.0100	0.062	0.062	0.017	0.030	Lognormal	9,602	0.062	#	--	[CEB]
Total Organic Carbon	µg/g	3 / 3	3 / 3	100%	--	--	22,500	45,300	--	--	Undetermined	--	45,300	#	--	[CEB]

Table 4-41. Summary Statistics and Exposure Point Concentrations for Soil (0-<1 ft BLS) at Study Area 16 - Flashing Ground (Continued)
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 11:59:57 AM
Run Date: 3/31/99
Exposure Unit: 16__SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]	2 x BK Mean[g]	Background Comparison[g]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: If the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-43. Summary Statistics and Exposure Point Concentrations for Soil (>10 ft BLS) at Study Area 16 - Flashing Ground
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 11:59:57 AM
Run Date: 3/31/99
Exposure Unit: 16_SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	2 / 2	2 / 2	100%	--	--	8,300	10,000	--	--	Undetermined	--	10,000	#	27,567	[bk]
Arsenic	µg/g	2 / 2	2 / 2	100%	--	--	17	56	--	--	Undetermined	--	56	#	52	[CEB]
Barium	µg/g	2 / 2	2 / 2	100%	--	--	6.9	7.3	--	--	Undetermined	--	7.3	#	41	[bk]
Beryllium	µg/g	1 / 2	1 / 2	50%	0.25	0.25	0.73	0.73	--	--	Undetermined	--	0.73	#	0.89	[bk]
Chromium	µg/g	2 / 2	2 / 2	100%	--	--	25	26	--	--	Undetermined	--	26	#	53	[bk]
Cobalt	µg/g	2 / 2	2 / 2	100%	--	--	7.7	12	--	--	Undetermined	--	12	#	58	[bk]
Copper	µg/g	2 / 2	2 / 2	100%	--	--	15	32	--	--	Undetermined	--	32	#	56	[bk]
Iron	µg/g	2 / 2	2 / 2	100%	--	--	40,000	44,000	--	--	Undetermined	--	44,000	#	57,000	[bk]
Lead	µg/g	10 / 13	10 / 13	77%	10.0	10.0	5.2	26	15	7.6	Normal	19	19		32	[bk]
Magnesium	µg/g	1 / 2	1 / 2	50%	138	138	256	256	--	--	Undetermined	--	256	#	867	[bk]
Manganese	µg/g	2 / 2	2 / 2	100%	--	--	31	87	--	--	Undetermined	--	87	#	1,331	[bk]
Molybdenum	µg/g	2 / 2	2 / 2	100%	--	--	6.3	9.4	--	--	Undetermined	--	9.4	#	--	[CEB]
Nickel	µg/g	1 / 2	1 / 2	50%	7.5	7.5	20	20	--	--	Undetermined	--	20	#	46	[bk]
Potassium	µg/g	2 / 2	2 / 2	100%	--	--	325	619	--	--	Undetermined	--	619	#	1,206	[bk]
Vanadium	µg/g	2 / 2	2 / 2	100%	--	--	52	56	--	--	Undetermined	--	56	#	92	[bk]
Zinc	µg/g	2 / 2	2 / 2	100%	--	--	32	73	--	--	Undetermined	--	73	#	104	[bk]
Acetone	µg/g	1 / 4	1 / 4	25%	0.045	0.045	0.24	0.24	0.077	0.11	Lognormal	17	0.24	#	--	[CEB]
Diethyl Phthalate	µg/g	1 / 4	1 / 4	25%	0.35	0.35	0.88	0.88	0.35	0.35	Lognormal	4.6	0.88	#	--	[CEB]
Toluene	µg/g	1 / 4	1 / 4	25%	0.0025	0.0025	0.0042	0.0042	0.0020	0.0015	Lognormal	0.0090	0.0042	#	--	[CEB]
Total Organic Carbon	µg/g	1 / 4	1 / 4	25%	1000	1000	3,500	3,500	1,250	1,500	Lognormal	50,250	3,500	#	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.

[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).

[c] CRL - contract reporting limit.

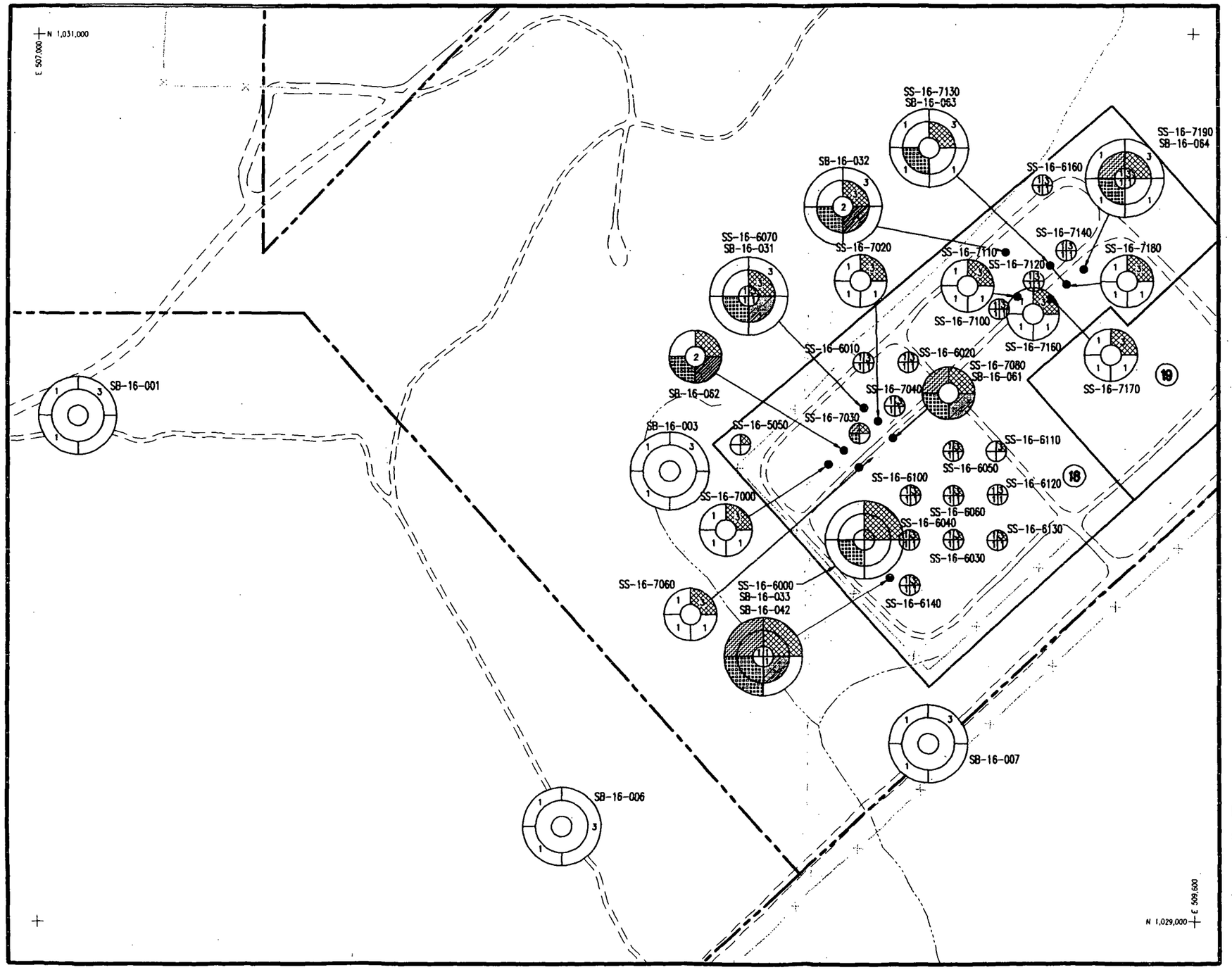
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).

[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.

[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.

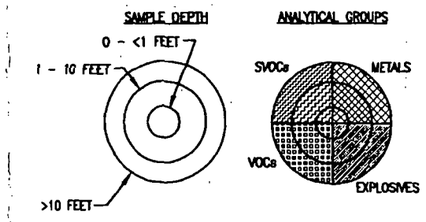
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.

-- Not applicable (note: background comparison not conducted for organic compounds)

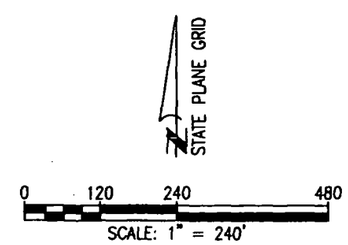


LEGEND:

- SECONDARY ROAD
- AREA BOUNDARY
- STUDY AREA
- SURFACE SOIL CONFIRMATION SAMPLE
- SOIL BORING CONFIRMATION SAMPLE
- ALABAMA STATE PLANE GRID (EAST)
- SAMPLE LOCATION



NOTE:
1 Contaminant group not analyzed at this depth.
2 Soil excavated to 2 ft/bgs.
3 Lead analysis only (for SB-16-031, -032, and -064 "3" indicates lead and mercury only).



U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

CEBs in Soil at Study Area 16

Figure No.	Project No.	File Name	Date
4-27	01-0331-03-8178-045	99015\DWGS\E420IE23	03-31-99

Metals—Eighteen metals were detected in Study Area 16 soils at concentrations exceeding background. The metals and their maximum concentrations in each soil interval where concentrations exceeded background are listed in the adjacent box.

Maximum Concentrations*			
Analyte (µg/g)	0-<1ft**	1-10ft	>10ft**
Aluminum	24,000		
Arsenic	27		56
Barium	463	197	
Beryllium		1.84	
Cadmium	31.9	**1.08**	
Calcium		20,000	
Cobalt	25	7.53	
Copper	1,600	326	
Iron	51,000		
Lead	**5,400**	**5,100**	
Magnesium	7,200	2,450	
Mercury	1.5	0.161	
Molybdenum			9.4
Nickel	71		
Potassium	1,190		
Sodium		**158**	
Vanadium	78		
Zinc	180	1,580	

* Metals also determined to exceed background based on ANOVA evaluation are shown in bold.
** ANOVA evaluation was not conducted for any metals except lead because there are fewer than four samples in the data set.

Lead was detected at concentrations exceeding background in 16 of the 21 surface soil sampling locations. The four highest lead concentrations (5,400, 2,900, 2,360, and 730 µg/g) reported for surface soils were detected in surface samples collected in Burning Pit 2. Lead was detected at concentrations exceeding background in 46 of the 51 shallow subsurface samples (including samples collected in conjunction with excavation activities). The highest subsurface lead concentration (5,100 µg/g) was detected at 2 feet BLS at a location in Burning Pit 3 (SS-16-7060). Lead concentrations in deep subsurface soils did not exceed background.

Cadmium was detected in one surface and two shallow subsurface soil samples at concentrations above the background. Cadmium was detected at a concentration exceeding background in a shallow subsurface sample collected from SB-16-061, located in Burning Pit 3, immediately to the east of the location in Burning Pit 2 (SB-16-7030), where cadmium was detected at a concentration above background in surface soil. Cadmium also exceeded background in the 1-foot BLS sample from SB-16-064, which is located in the northern portion of Study Area 16. The concentration of cadmium detected in the subsurface soil was approximately 30 times less than the concentration reported in surface soils.

Explosives—Field screening results for explosives within Study Area 16 are shown on Sheets 4-5 and 4-6. Explosives were detected in 21 Supplemental RI surface soil samples at concentrations ranging from 3.25 to 816 µg/g, with the highest explosives concentrations (816 and 176 µg/g) in subsurface soils (2 to 3 feet BLS) at Burning Pit 3. Samples from Burning Pits 1, 2, and 4 contained lower explosives concentrations (all less than 43 µg/g). Explosives also were reported in surface samples collected elsewhere at the site; one surface soil sampling location in the burning ground in the southeastern portion of the study area contained 44 µg/g of explosives. Thirty-three subsurface soil samples collected from eight soil borings were screened for explosives; however, explosives were detected in only two subsurface samples collected from one boring (SB-16-061) located in Burning Pit 3 (Sheet 4-6).

Explosives were not detected during laboratory confirmatory analysis of surface samples collected at Study Area 16; however, seven explosives were detected in shallow subsurface soils at Study Area 16. These seven explosives and their maximum concentrations in shallow subsurface soils are listed in the adjacent box. Maximum concentrations of 1,3,5-TNB, 2-A-4,6-DNT, and 4-A-2,6-DNT were detected in Supplemental RI borings SB-16-061 and SB-16-062, which are located in the area of Burning Pits 2 and 3. Maximum concentrations of TNT, 2,4-DNT, 2,6-DNT, and tetryl were detected in Roy F. Weston's excavation samples. Explosives were not detected in the deep subsurface soils.

Maximum Concentrations			
Analyte (µg/g)	0-<1ft	1-10ft	>10ft
1,3,5-TNB		3.23	
TNT		95*	
2,4-DNT		33*	
2,6-DNT		2.7*	
2-A-4,6-DNT		0.393	
4-A-2,6-DNT		0.434	
Tetryl		2*	

* Roy F. Weston data.

VOCs—Four VOCs were detected in soils at Study Area 16. The maximum concentrations in Study Area 16 soils are listed in the adjacent box.

Maximum Concentrations			
Analyte (µg/g)	0-<1ft	1-10ft	>10ft
Acetone		0.6	0.24
Chloroethane		0.0014	
Methylene chloride	0.0079	0.01	
Toluene	0.062	0.053	0.0042

The concentrations of methylene chloride, acetone, and chloromethane detected in Study Area 16 samples are not indicative of significant VOC contamination in the surface and subsurface soils. Methylene chloride was detected in one surface and three shallow subsurface soil samples at Study Area 16 at concentrations near the detection limit (0.00616 µg/g). Acetone was detected in three shallow subsurface samples and one deep subsurface sample. Results of acetone analyses for samples collected before June 19, 1995, as were all four samples with acetone, are believed suspect as a result of field laboratory activities. Chloroethane was detected in one shallow subsurface soil sample (SB-016-033; 1-foot BLS) at a concentration that was below the CRL.

Toluene was detected in one surface, six shallow subsurface, and one deep soil sample. Half of the toluene detections were at concentrations less than 0.007; in general, toluene concentrations decreased with depth.

SVOCs—Twenty SVOCs were detected in Study Area 16 soils. Their maximum detected concentrations are listed in the adjacent box. Most SVOCs (primarily PAHs) were reported at less than 1 µg/g, although nine PAHs and di-N-butyl phthalate were detected at concentrations greater than 1 µg/g in subsurface

Maximum Concentrations			
Analyte (µg/g)	0-<1ft	1-10ft	>10ft
2-methylnaphthalene	0.24		
Acenaphthene	0.39		
Anthracene	0.93		
Benzo(a)anthracene	2.6	0.57	
Benzo(a)pyrene	2.8	0.62	
Benzo(b)fluoranthene	4.4	0.99	
Benzo(g,h,i)perylene	1.4		
Benzo(k)fluoranthene	1.6	0.53	
Chrysene	3	0.56	
Dibenzo(a,h)anthracene	0.38		
Dibenzofuran	0.21		
Diethyl phthalate			0.88
di-N-butyl phthalate	4.2	0.67	
Fluoranthene	5.6	1.3	
Fluorene	0.36		
Indeno(1,2,3-cd)pyrene	1.4		
Naphthalene	0.36		
N-Nitrosodiphenylamine	0.09		
Phenanthrene	3.4	0.76	
Pyrene	5.8		

soil sample SS-16-7030, located in the area of Burning Pit 2. Sample SS-16-7030 was the only surface sample in which SVOCs were detected. Most of the shallow subsurface PAHs detected were present in the 1-foot BLS sample collected from SB-16-064, located at the northern end of Pit 4 in the northern portion of the study area. Diethyl phthalate was reported in one deep subsurface sample collected in the southeastern portion of the study area (SB-16-042; 25 feet BLS).

Summary—Explosives and lead contamination above applicable criteria was detected in the soils at Study Area 16 during the Phase 1 Supplemental RI sampling. The screening and confirmatory results from samples collected during Phase 1 resulted in remediation of soils in the area of Burning Pits 2 and 3. Roy F. Weston excavated and incinerated soils with explosives or explosives and lead concentrations above applicable criteria. ECC conducted remediation for the resultant lead-contaminated incinerator ash and for remaining soils with lead concentrations in excess of 300 ppm.

Metals, explosives, VOCs, and SVOCs were detected in the soils remaining at Study Area 16. Lead concentrations up to 5,400 and 5,100 µg/g remain in the surface and subsurface soils, respectively, although mean lead concentrations all are below 500 µg/g. Seven explosives compounds were detected in the soils remaining at Study Area 16. The maximum detected explosives concentration was less than 100 µg/g (TNT at 95 µg/g).

Twenty SVOCs, the majority of which are PAHs, were detected in the soil samples collected at Study Area 16. Four VOCs were detected in Study Area 16 soils at concentrations less than 1 µg/g, with the majority of concentrations near or below detection limits. Nineteen of the detected SVOCs were present in the sample from SS-16-7030, which was the only surface soil sample in which SVOCs were detected. Most of the shallow subsurface PAHs were detected in the 1-foot BLS sample collected from SB-16-064 located in Burning Pit 4. Only one SVOC (diethyl phthalate) was detected in the deep subsurface soil samples. The presence of metals, explosives, and PAHs in Study Area 16 soils is likely related to the area's use as a burning ground.

4.5.11 Study Area 17 – Propellant Shipping Area

Study Area 17 is the Propellant Shipping Area. The lower portion of the area was used as a shipping area for smokeless powder while the upper portion was used for shipping high explosives (DA 1978). The 1986 RI (ESE 1986) noted a low incidence of nitroaromatic compounds detected in the soils sampled from this area.

During Phase 1 of the Supplemental RI, 41 surface soil screening samples were collected at Study Area 17 and analyzed for explosives in the field laboratory. Three confirmatory samples were collected from the surface and analyzed in the laboratory for metals, explosives, VOCs, and SVOCs. Two additional surface soil samples were analyzed in the laboratory for explosives only. Five borings were drilled in Study Area 17 and all depth intervals were screened for explosives. Twelve soil samples from five borings were collected from the subsurface and analyzed in the

laboratory. Confirmatory samples were analyzed for metals, explosives, VOCs, and SVOCs. During Phase 2, five borings were drilled to collect screening soil and in situ groundwater samples. A soil sample was not collected from two of the borings because rock was encountered. One confirmatory sample was collected from screening location SB-17-083 and analyzed in the laboratory for lead and explosives. Sheets 4-5 and 4-6 present the screening results for surface and subsurface soils, respectively, for Study Area 17.

Explosives hot spots were detected in surface soil screening samples collected from six locations during Phase 1 of the Supplemental RI. Based on SAIC's results, Roy F. Weston conducted a sampling program in September 1996 to delineate the extent of contamination around the hot spots at Study Area 17 so that remediation of the area could be conducted. The area was sampled by Roy F. Weston on 50-foot grids, and grab samples were screened for explosives in an onsite field laboratory. Ten grab samples were collected from each of the six hot spot locations (SS-17-0020, SS-17-0030, SS-17-0740, SS-17-1000, SS-17-1010, and SS-17-1020), for a total of 60 samples. Twelve confirmatory samples, each of which was a composite of five grab samples, were submitted for laboratory confirmatory analysis. Confirmatory samples were analyzed for explosives and total lead.

During the confirmatory analysis of the 12 samples from Study Area 17, 2,4-DNT was detected in 1 sample at 5.2 ppm. The excavation criterion for 2,4-DNT was 356 ppm. No other explosives were detected in any samples. Total lead was detected at a maximum concentration of 25.6 ppm, which was well below Roy F. Weston's lead excavation criterion of 500 ppm. Roy F. Weston's analytical results indicated that concentrations greater than excavation criteria were not present in Study Area 17 soils. However, to be conservative, USACE directed Roy F. Weston to excavate four of the hot spot grids (50 by 50 feet) in which elevated explosives concentrations were detected during the Supplemental RI conducted by SAIC. The four locations were SS-17-0020, SS-17-0030, SS-17-0740, and SS-17-1010. The proposed excavation depth was 2 feet BLS, which resulted in an excavation volume of 741 cubic yards. Following remediation, confirmatory samples were collected just below the excavation depth to verify that remediation was adequate.

The data summary tables for SAIC Supplemental RI Study Area 17 are presented in Appendix K. Roy F. Weston post-excavation confirmatory data are presented in Appendix L. For the purposes of statistical analysis, the Supplemental RI data collected from the four locations that subsequently were remediated were removed from the data set. The Roy F. Weston post-excavation confirmatory data were included in the statistical analysis, as follows:

- 17EXCF1267 replaced SS-17-0020
- 17EXCF1268 replaced SS-17-0740
- 17EXCF1269 replaced SS-17-0030
- 17EXCF1270 replaced SS-17-1010.

Summary statistics for the soils remaining in Study Area 17 are shown in **Tables 4-44** through **4-46**. These tables present statistics for chemicals detected in the surface or subsurface soils remaining at Study Area 17 after the remedial activities. **Figure 4-28** shows the locations where the general contaminant group CEBs (metals, SVOCs, VOCs, and explosives) were detected in the soils remaining at Study Area 17 after remediation. The lack of quadrants in a circle indicates that a soil sample was not collected at that interval.

Metals—Fifteen metals exceeded background in Study Area 17 soils (listed in the adjacent box). The maximum surface soil concentrations of aluminum, arsenic, barium, beryllium, iron, and nickel all were detected in sample SS-17-1000, which was located at the northern end of Study Area 17. Manganese was detected at a maximum surface soil concentration in sample SS-17-0010. Molybdenum, which was detected above background in one deep subsurface sample (SB-17-035, 25 feet BLS), was not detected in any other soil samples at Study Area 17. The maximum arsenic detections in both Study Area 17 subsurface soil intervals were the highest detected throughout Area B during the Supplemental RI. The arsenic background exceedances were detected in samples located in the northern half of Study Area 17. Lead exceeded background in all shallow subsurface soil samples, although the maximum detected concentration was less than 25 µg/g. In general, other metals concentrations that exceeded background were randomly distributed.

Maximum Concentrations*			
Analyte (µg/g)	**0-<1ft****	**1-10ft**	**>10ft**
Aluminum	29,000		
Arsenic	46.6	54.1	82.3
Barium	271		
Beryllium	3.57	0.826	1.27
Calcium	52,000		398
Chromium		114	
Copper	14.6		
Iron	40,000		
Lead		**23.1**	
Magnesium	12,000		
Manganese	2,400	690	
Molybdenum			**12.8**
Nickel	13.6	21.6	
Potassium	3,000		
Sodium		**76.3**	

* Metals also determined to exceed background based on ANOVA evaluation are shown in bold.

** ANOVA evaluation was not conducted because there are fewer than four samples in the data set.

Explosives—Forty-one surface and three subsurface soil samples were collected and screened in the field for explosives. Concentrations ranged from <2.5 to 1,492 µg/g. Of these, five surface soil results were more than 100 µg/g, as shown in Sheets 4-5 and 4-6. As discussed previously, soils around four locations have been remediated. Samples collected from soils that remain at Study Area 17 indicated the presence of 2,4,-DNT in two samples.

2,4-DNT was detected at a concentration (0.0844 µg/g) below the CRL (0.31 µg/g) in surface soil sample SS-17-1000. The 25-foot BLS sample from boring SB-17-035 also contained 2,4-DNT at a concentration (0.064 µg/g) below the CRL. Explosives were not detected in the post-excavation confirmatory samples.

Table 4-44. Summary Statistics and Exposure Point Concentrations for Soil (0-<1 ft BLS) at Study Area 17 - Propellant Shipping Area
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:57:48 PM
Run Date: 3/29/99
Exposure Unit: 17__SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	2 / 2	2 / 2	100%	--	--	12,000	29,000	--	--	Undetermined	--	29,000	#	20,277	[CEB]
Arsenic	µg/g	1 / 2	1 / 2	50%	13	13	47	47	--	--	Undetermined	--	47	#	15	[CEB]
Barium	µg/g	2 / 2	2 / 2	100%	--	--	142	271	--	--	Undetermined	--	271	#	124	[CEB]
Beryllium	µg/g	2 / 2	2 / 2	100%	--	--	0.70	3.6	--	--	Undetermined	--	3.6	#	0.82	[CEB]
Calcium	µg/g	2 / 2	2 / 2	100%	--	--	691	52,000	--	--	Undetermined	--	52,000	#	4,960	[CEB]
Chromium	µg/g	2 / 2	2 / 2	100%	--	--	35	36	--	--	Undetermined	--	36	#	54	[bk]
Cobalt	µg/g	1 / 2	1 / 2	50%	2.5	2.5	5.6	5.6	--	--	Undetermined	--	5.6	#	14	[bk]
Copper	µg/g	2 / 2	2 / 2	100%	--	--	4.7	15	--	--	Undetermined	--	15	#	13	[CEB]
Iron	µg/g	2 / 2	2 / 2	100%	--	--	23,000	40,000	--	--	Undetermined	--	40,000	#	37,560	[CEB]
Lead	µg/g	2 / 2	2 / 2	100%	--	--	15	18	--	--	Undetermined	--	18	#	34	[bk]
Magnesium	µg/g	2 / 2	2 / 2	100%	--	--	437	12,000	--	--	Undetermined	--	12,000	#	1,189	[CEB]
Manganese	µg/g	2 / 2	2 / 2	100%	--	--	1000	2,400	--	--	Undetermined	--	2,400	#	1,730	[CEB]
Nickel	µg/g	1 / 2	1 / 2	50%	7.5	7.5	14	14	--	--	Undetermined	--	14	#	9.4	[CEB]
Potassium	µg/g	2 / 2	2 / 2	100%	--	--	445	3,000	--	--	Undetermined	--	3,000	#	680	[CEB]
Sodium	µg/g	1 / 2	1 / 2	50%	50	50	284	284	--	--	Undetermined	--	284	#	501	[bk]
Vanadium	µg/g	2 / 2	2 / 2	100%	--	--	38	72	--	--	Undetermined	--	72	#	76	[bk]
2,4-Dinitrotoluene	µg/g	1 / 3	1 / 2	50%	0.054	0.056	0.084	0.084	--	--	Undetermined	--	0.084	#	--	[CEB]
Toluene	µg/g	1 / 2	1 / 2	50%	0.0025	0.0025	0.0033	0.0033	--	--	Undetermined	--	0.0033	#	--	[CEB]
Total Organic Carbon	µg/g	2 / 2	2 / 2	100%	--	--	21,500	27,100	--	--	Undetermined	--	27,100	#	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-45. Summary Statistics and Exposure Point Concentrations for Soil (1-10 ft BLS) at Study Area 17 - Propellant Shipping Area
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:57:48 PM
Run Date: 3/29/99
Exposure Unit: 17__SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	4 / 4	4 / 4	100%	--	--	11,000	24,000	15,250	5,909	Lognormal	27,678	24,000	#	27,733	[bk]
Arsenic	µg/g	3 / 4	3 / 4	75%	13	13	17	54	32	24	Normal	60	54	#	42	[CEB][ANOVA]
Barium	µg/g	4 / 4	4 / 4	100%	--	--	7.4	48	27	19	Normal	49	48	#	64	[bk]
Beryllium	µg/g	3 / 4	3 / 4	75%	0.25	0.25	0.52	0.83	0.57	0.33	Normal	0.96	0.83	#	0.80	[CEB][ANOVA]
Calcium	µg/g	3 / 4	3 / 4	75%	109	109	165	423	204	156	Normal	387	387		2,475	[bk]
Chromium	µg/g	2 / 4	2 / 4	50%	23	32	25	114	42	49	Lognormal	2,449	114	#	46	[CEB][ANOVA]
Cobalt	µg/g	2 / 4	2 / 4	50%	2.5	2.5	4.5	6.2	3.3	2.5	Normal	6.2	6.2		7.0	[bk]
Copper	µg/g	4 / 4	4 / 4	100%	--	--	4.5	25	16	10	Normal	27	25	#	26	[bk]
Iron	µg/g	4 / 4	4 / 4	100%	--	--	24,000	50,000	37,250	12,258	Normal	51,673	50,000	#	52,000	[bk]
Lead	µg/g	7 / 8	7 / 8	88%	10.0	10.0	14	23	16	5.9	Normal	20	20		14	[CEB]
Magnesium	µg/g	4 / 4	4 / 4	100%	--	--	234	740	464	242	Normal	749	740	#	1,399	[bk]
Manganese	µg/g	4 / 4	4 / 4	100%	--	--	80	690	271	285	Normal	606	606		682	[CEB][ANOVA]
Mercury	µg/g	1 / 4	1 / 4	25%	0.087	0.087	0.12	0.12	0.062	0.038	Lognormal	0.18	0.12	#	0.12	[bk]
Nickel	µg/g	3 / 4	3 / 4	75%	7.5	7.5	11	22	14	8.7	Normal	25	22	#	21	[CEB][ANOVA]
Potassium	µg/g	4 / 4	4 / 4	100%	--	--	216	1,190	649	414	Normal	1,136	1,136		1,324	[bk]
Sodium	µg/g	1 / 4	1 / 4	25%	50	50	76	76	38	26	Lognormal	139	76	#	--	[CEB]
Vanadium	µg/g	4 / 4	4 / 4	100%	--	--	50	73	61	12	Normal	74	73	#	96	[bk]
Zinc	µg/g	2 / 4	2 / 4	50%	73	75	17	38	32	10	Lognormal	69	38	#	71	[bk]
Toluene	µg/g	2 / 5	2 / 5	40%	0.0025	0.0025	0.0047	0.025	0.0067	0.010	Lognormal	0.47	0.025	#	--	[CEB]
Total Organic Carbon	µg/g	3 / 4	3 / 4	75%	1000	1000	4,090	17,200	6,568	7,311	Normal	15,170	15,170		--	[CEB]

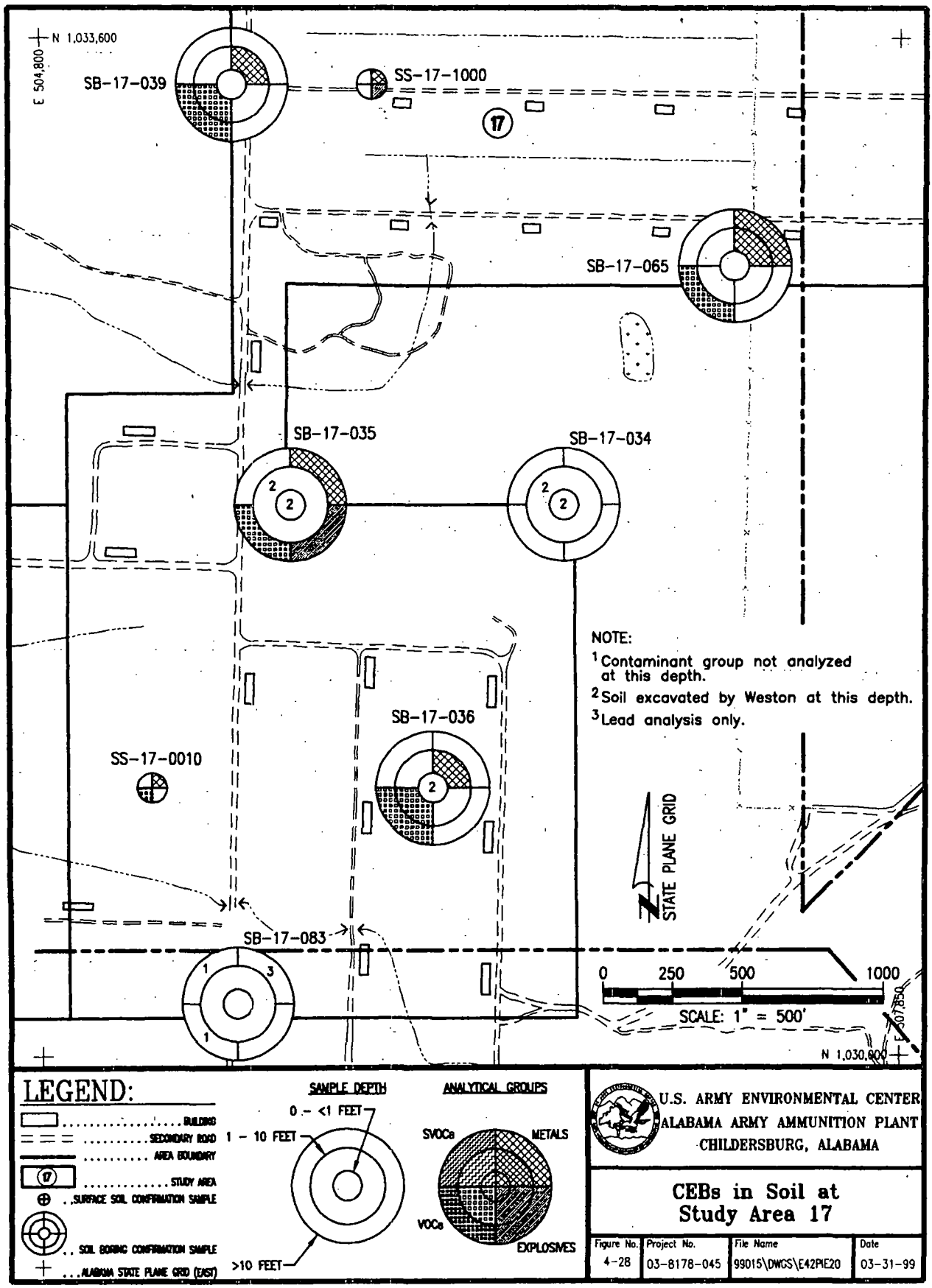
[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-46. Summary Statistics and Exposure Point Concentrations for Soil (>10 ft BLS) at Study Area 17 - Propellant Shipping Area
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:57:48 PM
Run Date: 3/29/99
Exposure Unit: 17_SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	5 / 5	5 / 5	100%	--	--	6,400	22,000	12,460	6,350	Normal	18,514	18,514		27,567	[bk]
Arsenic	µg/g	5 / 5	5 / 5	100%	--	--	17	82	36	27	Lognormal	108	82	#	52	[CEB][ANOVA]
Barium	µg/g	5 / 5	5 / 5	100%	--	--	9.0	21	13	5.1	Normal	18	18		41	[bk]
Beryllium	µg/g	3 / 5	3 / 5	60%	0.25	0.25	0.42	1.3	0.49	0.47	Normal	0.94	0.94		0.89	[CEB][ANOVA]
Calcium	µg/g	2 / 5	2 / 5	40%	109	109	143	398	141	149	Lognormal	1,032	398	#	257	[CEB][ANOVA]
Chromium	µg/g	4 / 5	4 / 5	80%	21	21	15	36	23	11	Normal	34	34		53	[bk]
Cobalt	µg/g	4 / 5	4 / 5	80%	2.5	2.5	5.3	13	7.5	4.3	Normal	12	12		58	[bk]
Copper	µg/g	5 / 5	5 / 5	100%	--	--	12	28	20	7.4	Normal	27	27		56	[bk]
Iron	µg/g	5 / 5	5 / 5	100%	--	--	15,000	55,000	34,400	18,770	Normal	52,295	52,295		57,000	[bk]
Lead	µg/g	5 / 6	5 / 6	83%	10.0	10.0	15	32	20	9.6	Normal	28	28		32	[bk]
Magnesium	µg/g	4 / 5	4 / 5	80%	138	138	188	629	315	210	Normal	516	516		867	[bk]
Manganese	µg/g	5 / 5	5 / 5	100%	--	--	76	227	150	69	Normal	216	216		1,331	[bk]
Mercury	µg/g	1 / 5	1 / 5	20%	0.087	0.087	0.22	0.22	0.079	0.079	Lognormal	0.31	0.22	#	0.36	[bk]
Molybdenum	µg/g	1 / 5	1 / 5	20%	4.0	4.0	13	13	4.2	4.8	Lognormal	23	13	#	--	[CEB]
Nickel	µg/g	4 / 5	4 / 5	80%	7.5	7.5	15	27	16	8.2	Normal	24	24		46	[bk]
Potassium	µg/g	5 / 5	5 / 5	100%	--	--	295	970	580	277	Normal	845	845		1,206	[bk]
Vanadium	µg/g	5 / 5	5 / 5	100%	--	--	20	87	54	29	Normal	82	82		92	[bk]
Zinc	µg/g	4 / 5	4 / 5	80%	99	99	26	61	44	13	Normal	56	56		104	[bk]
2,4-Dinitrotoluene	µg/g	1 / 6	1 / 6	17%	0.054	0.16	0.064	0.064	0.042	0.024	Lognormal	0.077	0.064	#	--	[CEB]
Acetone	µg/g	2 / 5	2 / 5	40%	0.025	0.067	0.92	1.00	0.40	0.51	Lognormal	73,940	1.00	#	--	[CEB]
Methylene Chloride	µg/g	1 / 5	1 / 5	20%	0.0062	0.011	0.0047	0.0047	0.0043	0.0011	Normal	0.0053	0.0047	#	--	[CEB]
Toluene	µg/g	2 / 5	2 / 5	40%	0.0025	0.0025	0.0035	0.0038	0.0022	0.0013	Lognormal	0.0059	0.0038	#	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)


N 1,033,600
E 504,800
SB-17-039
SS-17-1000
17
SB-17-065
SB-17-035
SB-17-034
SB-17-036
SS-17-0010
SB-17-083
NOTE:
1 Contaminant group not analyzed at this depth.
2 Soil excavated by Weston at this depth.
3 Lead analysis only.
STATE PLANE GRID
0 250 500 1000
SCALE: 1" = 500'
N 1,030,900
LEGEND:
BUILDING
SECONDARY ROAD
AREA BOUNDARY
STUDY AREA
SURFACE SOIL CONFIRMATION SAMPLE
SOIL BORING CONFIRMATION SAMPLE
ALABAMA STATE PLANE GRID (EAST)
SAMPLE DEPTH
0 - <1 FEET
1 - 10 FEET
>10 FEET
ANALYTICAL GROUPS
SVOCs
METALS
VOCs
EXPLOSIVES
U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA
CEBs in Soil at Study Area 17
Figure No. 4-28
Project No. 03-8178-045
File Name 99015\DWGS\E42PIE20
Date 03-31-99

VOCs—Three VOCs were detected in Study Area 17 soils and are listed in the adjacent box. The highest concentration of acetone was detected at SB-17-036 at a concentration of 1 µg/g in the 25-foot BLS interval. Acetone also was detected in the 25-foot BLS sample at SB-17-039. Results of acetone analyses for samples collected before June 19, 1995 (as was the sample from SB-17-036), are believed to be suspect as a result of field laboratory activities. (Section 4.2 provides an additional explanation.) Methylene chloride was detected in one deep subsurface soil sample (SB-17-039; 25 feet BLS) at a concentration below the CRL. Toluene was detected in five samples, all at concentrations near the CRL.

Maximum Concentrations			
Analyte (µg/g)	0-<1ft	1-10ft	>10ft
Acetone			1
Methylene Chloride			0.0047
Toluene	0.0033	0.025	0.0038

SVOCs—SVOCs were not detected in the soils at Study Area 17.

Summary—Metals, one explosive, and VOCs were detected above background concentrations in soils sampled within Study Area 17. Metals exceeding background generally were randomly distributed across the study area. Subsurface concentrations of arsenic detected at Study Area 17 were the highest detected throughout Area B during the Supplemental RI. Arsenic concentrations were highest in the northern half of the study area, although there is no known source for arsenic in this area.

The screening and confirmatory results for explosives resulted in remediation of the soils around four locations sampled by Roy F. Weston. A total of 741 cubic yards of soil were excavated and remediated. Supplemental RI and remediation confirmatory sampling indicate that no explosives remain in the soil at concentrations greater than the CRL (0.31 µg/g). 2,4-DNT was detected at lower concentrations in one surface soil sample and one subsurface soil sample. Acetone was detected in two subsurface soil samples at a maximum concentration of 1 µg/g. The two other detected VOCs (methylene chloride and toluene) were detected at concentrations near the CRL. SVOCs were not detected.

4.5.12 Study Area 18 – Blending Tower Area

Study Area 18 was described in the Installation Assessment (DA 1978) as the blending area where the smokeless powder was mixed to make it more homogeneous. The equipment consisted of an upper and lower bin. During the blending operation, the powder was moved to an upper bin pneumatically and then dropped over an umbrella into the lower bin. This procedure was repeated twice (DA 1978). Historical drawings of the installation indicate that the blending area was actually to the south of the Area B property. Study Area 18 is believed to be part of the Propellant Shipping Area for the smokeless powder. This area has not been investigated before the current Supplemental RI activities.

Seven soil sampling locations were established at Study Area 18 during the Phase I Supplemental RI. Surface soil samples were collected from these locations and screened for explosives in the field laboratory. Six surface soil samples were selected and sent to the laboratory for confirmatory analysis. In addition, two borings were drilled in Study Area 18 during Phase 1, and each 5-foot interval was sampled and screened for explosives. Soil samples were collected from each of the borings at two depth intervals and sent to the laboratory for confirmatory analyses. All confirmatory soil samples were analyzed for metals, explosives, VOCs, and SVOCs. During Phase 2, six borings were drilled for collection of screening soil and in situ groundwater samples. A soil screening sample was not collected from two of the borings because rock was encountered. One sample from each of three borings (SB-18-076, SB-18-077, and SB-18-078) was sent to the laboratory for confirmatory analysis. These three samples were analyzed for lead and explosives.

Appendix K presents data summary tables for Study Area 18. **Tables 4-47** through **4-49** present summary statistics for Study Area 18 soils. **Figure 4-29** shows the locations where the general contaminant group CEBs (metals, SVOCs, VOCs, and explosives) were detected in Study Area 18 soils. The lack of quadrants in a circle indicates that a soil sample was not collected at that interval. Sheets 4-5 and 4-6 present the screening results for surface and subsurface soils, respectively, for Study Area 18.

Metals—Nine metals exceeded background concentrations in Study Area 18 soils (see the adjacent box). Five metals (arsenic, chromium, iron, manganese, and vanadium) were present in the surface soils at concentrations that exceeded background. Four of the five maximum concentrations for metals were present in one sample (SS-18-1030). The maximum concentration for manganese was present in sample SS-18-0000. Barium, cobalt, lead, and manganese were detected at maximum concentrations in the shallow subsurface soils at location SB-18-038. Chromium was detected at a maximum concentration in the shallow subsurface sample at location SB-18-037. Locations SB-18-037 and SB-18-038 are both located along the eastern boundary of Study Area 18. The detected copper concentration in the 25-foot BLS interval at location SB-18-037 (144 µg/g) was the maximum detected in deep subsurface soils throughout Area B during the Supplemental RI. Metals concentrations did not vary consistently with depth. For example, copper concentrations increased with depth, while lead concentrations tended to decrease.

Maximum Concentrations*			
Analyte (µg/g)	0-<1ft	1-10ft**	>10ft**
Arsenic	40.7		
Barium		96.1	
Chromium	80.8	69.7	
Cobalt		7.41	
Copper			144
Iron	66,000		
Lead		16.2	
Manganese	2,000	1,600	
Vanadium	98.3		

* Metals also determined to exceed background based on ANOVA evaluation are shown in bold.

** ANOVA evaluation not conducted because there are fewer than four samples in the data set.

Table 4-47. Summary Statistics and Exposure Point Concentrations for Soil (0-<1 ft BLS) at Study Area 18 - Blending Tower Area
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:00:12 PM
Run Date: 3/29/99
Exposure Unit: 18_SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	5 / 5	5 / 5	100%	--	--	7,300	11,000	9,580	1,375	Normal	10,891	10,891		20,277	[bk]
Arsenic	µg/g	1 / 5	1 / 5	20%	13	13	41	41	13	15	Lognormal	74	41	#	15	[CEB][ANOVA]
Barium	µg/g	5 / 5	5 / 5	100%	--	--	41	109	75	30	Normal	104	104		124	[bk]
Beryllium	µg/g	4 / 5	4 / 5	80%	0.25	0.25	0.41	0.55	0.41	0.17	Normal	0.57	0.55	#	0.82	[bk]
Calcium	µg/g	5 / 5	5 / 5	100%	--	--	238	822	541	242	Normal	772	772		4,960	[bk]
Chromium	µg/g	3 / 5	3 / 5	60%	24	55	16	81	32	28	Lognormal	129	81	#	54	[CEB][ANOVA]
Cobalt	µg/g	2 / 5	2 / 5	40%	2.5	2.5	4.0	6.9	2.9	2.5	Normal	5.3	5.3		14	[bk]
Copper	µg/g	3 / 5	3 / 5	60%	3.4	3.4	5.1	6.8	4.4	2.6	Normal	6.8	6.8	#	13	[bk]
Iron	µg/g	5 / 5	5 / 5	100%	--	--	8,400	66,000	27,280	23,106	Normal	49,309	49,309		37,560	[CEB][ANOVA]
Lead	µg/g	5 / 5	5 / 5	100%	--	--	16	24	20	3.0	Normal	23	23		34	[bk]
Magnesium	µg/g	5 / 5	5 / 5	100%	--	--	252	364	296	43	Normal	337	337		1,189	[bk]
Manganese	µg/g	5 / 5	5 / 5	100%	--	--	350	2,000	1,150	673	Normal	1,791	1,791		1,730	[CEB][ANOVA]
Potassium	µg/g	5 / 5	5 / 5	100%	--	--	262	386	325	55	Normal	378	378		680	[bk]
Vanadium	µg/g	5 / 5	5 / 5	100%	--	--	20	98	45	33	Normal	76	76		76	[CEB][ANOVA]
Zinc	µg/g	2 / 5	2 / 5	40%	30	41	17	32	20	6.8	Normal	27	27		36	[bk]
2,4-Dinitrotoluene	µg/g	1 / 6	1 / 6	17%	0.054	0.31	0.069	0.069	0.055	0.052	Lognormal	0.16	0.069	#	--	[CEB]
Toluene	µg/g	1 / 5	1 / 5	20%	0.0025	0.0025	0.0045	0.0045	0.0019	0.0015	Lognormal	0.0048	0.0045	#	--	[CEB]
Total Organic Carbon	µg/g	5 / 5	5 / 5	100%	--	--	22,300	30,500	26,660	3,474	Normal	29,972	29,972		--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-48. Summary Statistics and Exposure Point Concentrations for Soil (1-10 ft BLS) at Study Area 18 - Blending Tower Area
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:00:12 PM
Run Date: 3/29/99
Exposure Unit: 18_SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	2 / 2	2 / 2	100%	--	--	16,000	24,000	--	--	Undetermined	--	24,000	#	27,733	[bk]
Barium	µg/g	2 / 2	2 / 2	100%	--	--	56	96	--	--	Undetermined	--	96	#	64	[CEB]
Beryllium	µg/g	2 / 2	2 / 2	100%	--	--	0.53	0.55	--	--	Undetermined	--	0.55	#	0.80	[bk]
Calcium	µg/g	2 / 2	2 / 2	100%	--	--	347	395	--	--	Undetermined	--	395	#	2,475	[bk]
Chromium	µg/g	2 / 2	2 / 2	100%	--	--	31	70	--	--	Undetermined	--	70	#	46	[CEB]
Cobalt	µg/g	2 / 2	2 / 2	100%	--	--	6.6	7.4	--	--	Undetermined	--	7.4	#	7.0	[CEB]
Copper	µg/g	2 / 2	2 / 2	100%	--	--	7.4	8.2	--	--	Undetermined	--	8.2	#	26	[bk]
Iron	µg/g	2 / 2	2 / 2	100%	--	--	21,000	21,000	--	--	Undetermined	--	21,000	#	52,000	[bk]
Lead	µg/g	1 / 2	1 / 2	50%	10.0	10.0	16	16	--	--	Undetermined	--	16	#	14	[CEB]
Magnesium	µg/g	2 / 2	2 / 2	100%	--	--	479	813	--	--	Undetermined	--	813	#	1,399	[bk]
Manganese	µg/g	2 / 2	2 / 2	100%	--	--	690	1,600	--	--	Undetermined	--	1,600	#	682	[CEB]
Potassium	µg/g	2 / 2	2 / 2	100%	--	--	426	560	--	--	Undetermined	--	560	#	1,324	[bk]
Vanadium	µg/g	2 / 2	2 / 2	100%	--	--	45	47	--	--	Undetermined	--	47	#	96	[bk]
Zinc	µg/g	2 / 2	2 / 2	100%	--	--	30	35	--	--	Undetermined	--	35	#	71	[bk]
Acetone	µg/g	1 / 2	1 / 2	50%	0.045	0.045	4.0	4.0	--	--	Undetermined	--	4.0	#	--	[CEB]
Toluene	µg/g	1 / 2	1 / 2	50%	0.0025	0.0025	0.038	0.038	--	--	Undetermined	--	0.038	#	--	[CEB]
Total Organic Carbon	µg/g	2 / 2	2 / 2	100%	--	--	4,490	6,820	--	--	Undetermined	--	6,820	#	--	[CEB]

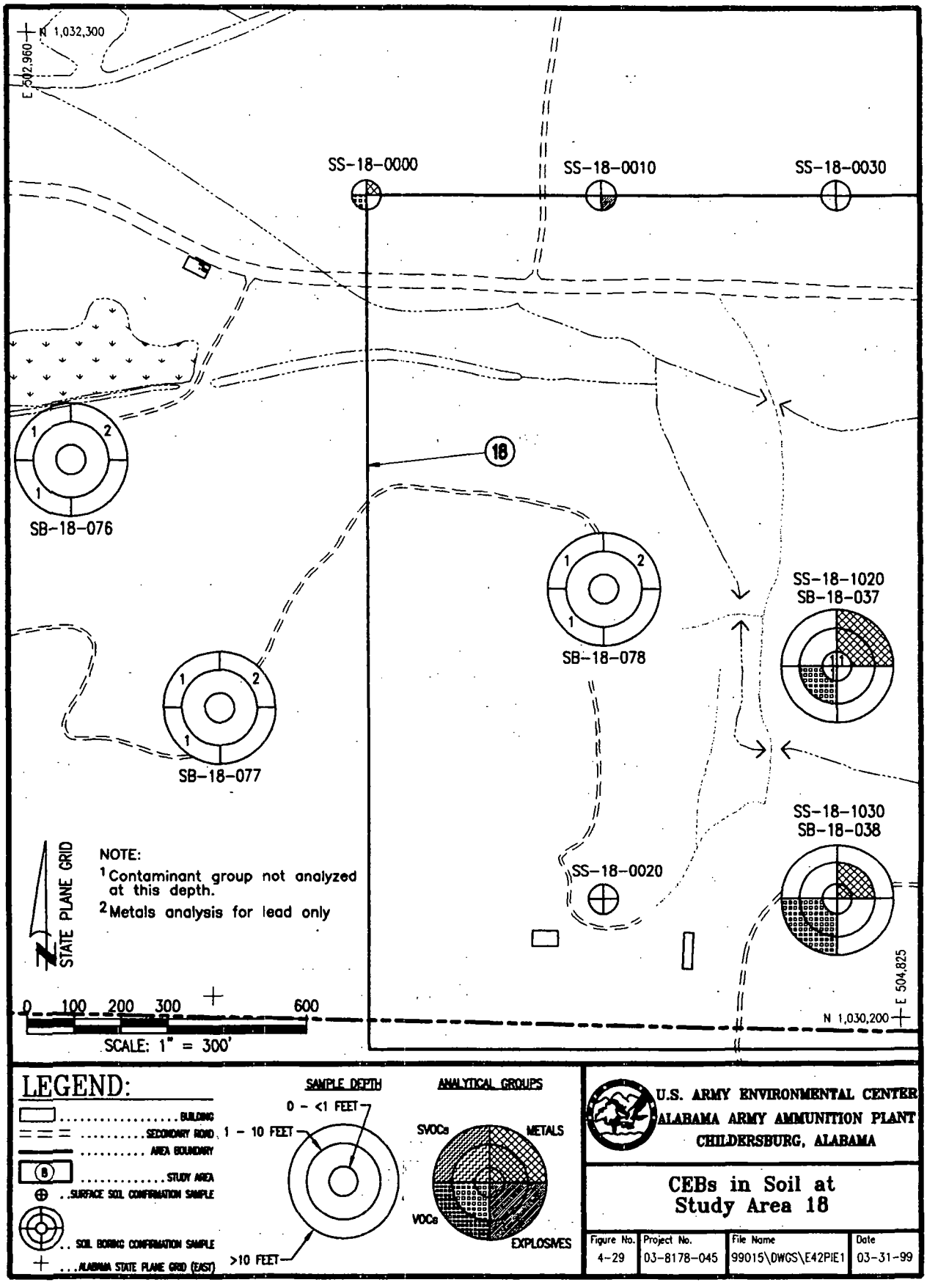
[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-49. Summary Statistics and Exposure Point Concentrations for Soil (>10 ft BLS) at Study Area 18 - Blending Tower Area
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:00:12 PM
Run Date: 3/29/99
Exposure Unit: 18__SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	2 / 2	2 / 2	100%	--	--	7,900	9,700	--	--	Undetermined	--	9,700	#	27,567	[bk]
Arsenic	µg/g	1 / 2	1 / 2	50%	13	13	21	21	--	--	Undetermined	--	21	#	52	[bk]
Barium	µg/g	2 / 2	2 / 2	100%	--	--	12	21	--	--	Undetermined	--	21	#	41	[bk]
Beryllium	µg/g	1 / 2	1 / 2	50%	0.25	0.25	0.44	0.44	--	--	Undetermined	--	0.44	#	0.89	[bk]
Calcium	µg/g	1 / 2	1 / 2	50%	109	109	191	191	--	--	Undetermined	--	191	#	257	[bk]
Chromium	µg/g	2 / 2	2 / 2	100%	--	--	19	23	--	--	Undetermined	--	23	#	53	[bk]
Copper	µg/g	2 / 2	2 / 2	100%	--	--	12	144	--	--	Undetermined	--	144	#	56	[CEB]
Iron	µg/g	2 / 2	2 / 2	100%	--	--	15,000	31,000	--	--	Undetermined	--	31,000	#	57,000	[bk]
Lead	µg/g	4 / 5	4 / 5	80%	10.0	10.0	8.8	30	17	10	Normal	27	27		32	[bk]
Magnesium	µg/g	2 / 2	2 / 2	100%	--	--	234	265	--	--	Undetermined	--	265	#	867	[bk]
Manganese	µg/g	2 / 2	2 / 2	100%	--	--	27	201	--	--	Undetermined	--	201	#	1,331	[bk]
Mercury	µg/g	1 / 2	1 / 2	50%	0.087	0.087	0.26	0.26	--	--	Undetermined	--	0.26	#	0.36	[bk]
Nickel	µg/g	1 / 2	1 / 2	50%	7.5	7.5	13	13	--	--	Undetermined	--	13	#	46	[bk]
Potassium	µg/g	2 / 2	2 / 2	100%	--	--	290	566	--	--	Undetermined	--	566	#	1,206	[bk]
Vanadium	µg/g	2 / 2	2 / 2	100%	--	--	37	49	--	--	Undetermined	--	49	#	92	[bk]
Zinc	µg/g	2 / 2	2 / 2	100%	--	--	23	77	--	--	Undetermined	--	77	#	104	[bk]
Acetone	µg/g	1 / 2	1 / 2	50%	0.043	0.043	0.14	0.14	--	--	Undetermined	--	0.14	#	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)


N 1,032,300
E 502,960
SS-18-0000
SS-18-0010
SS-18-0030
18
SB-18-076
SB-18-078
SS-18-1020
SB-18-037
SB-18-077
SS-18-1030
SB-18-038
SS-18-0020
STATE PLANE GRID
NOTE:
1 Contaminant group not analyzed at this depth.
2 Metals analysis for lead only
0 100 200 300 600
SCALE: 1" = 300'
E 504,825
N 1,030,200
LEGEND:
BUILDING
SECONDARY ROAD
AREA BOUNDARY
STUDY AREA
SURFACE SOIL CONFIRMATION SAMPLE
SOIL BORING CONFIRMATION SAMPLE
ALABAMA STATE PLANE GRID (EAST)
SAMPLE DEPTH
0 - <1 FEET
1 - 10 FEET
>10 FEET
ANALYTICAL GROUPS
SVOCs
METALS
VOCs
EXPLOSIVES
U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA
CEBs in Soil at Study Area 18
Figure No. 4-29
Project No. 03-8178-045
File Name 99015\DWGS\E42PIE1
Date 03-31-99

Explosives—The explosives screening results indicate that explosives contamination of the surface and subsurface soils is minimal; concentrations ranged from <2.5 to 32 µg/g. Six confirmatory samples were collected from the surface and analyzed for explosives, and only one (SS-18-0010) contained 2,4-DNT at a low concentration (0.069 µg/g) (see Sheet 4-5). Explosives were not detected in any subsurface soil samples.

VOCs—Two VOCs were detected in Study Area 18 soils and are listed in the adjacent box. Acetone was detected in samples from soil boring SB-18-038, at a concentration of 4 µg/g in the 1-foot BLS interval and 0.14 µg/g in the 25-foot BLS interval. Results of acetone analyses for samples collected before June 19, 1995 (as were samples from boring SB-18-038) are believed to be suspect as a result of field laboratory activities. (Section 4.2 provides additional explanation.) Toluene was detected in one surface soil sample (SS-18-0000) and one shallow subsurface soil sample (SB-18-037, 1 foot BLS). Toluene was not detected in the 25-foot BLS sample at location SB-18-037.

Maximum Concentrations			
Analyte (µg/g)	0-<1ft	1-10ft	>10ft
Acetone		>4	>0.14
Toluene	0.0045	0.038	

SVOCs—SVOCs were not detected in soils at Study Area 18.

Summary—Metals, one explosive, and two VOCs were detected above background concentrations in soils sampled within Study Area 18. Nine metals exceeded background in the Study Area 18 soils. There was no consistent trend with respect to metals distributions in the soils. The results of the explosives field screening data for Study Area 18 showed concentrations of explosives less than 33 µg/kg in three of the surface soil screening samples. 2,4-DNT was detected in only one confirmatory soil sample at a concentration near the CRL. No subsurface soil explosives contamination was detected. Two VOCs (acetone and toluene) were detected in the Study Area 18 soils. Each of these compounds was detected in only two samples. The presence of acetone may be related to field laboratory activities.

4.5.13 Study Area 19 – Lead Facility

Study Area 19 is a 350- by 550-foot area used during the production years for pouring lead ingots (DA 1978). At the time of the environmental survey, numerous large pieces of lead, some weighing several pounds, remained on the soil surface in this area and had been discarded outside the Flashing Ground fence. Sparse vegetation was observed at the time, possibly as a result of soil contamination. High levels of lead were detected in soil samples collected during previous investigations.

Nineteen soil sampling locations were established at Study Area 19 during Phase 1 of the Supplemental RI. A surface soil sample was collected from one soil sampling location (SS-19-5050) and screened for explosives in the field laboratory (Sheet 4-5). Surface soil samples from 15 sampling locations were screened for lead on a quick-turnaround basis in an offsite

laboratory. Surface soil samples from two locations also were submitted for laboratory confirmatory analysis of metals, hexavalent chromium, explosives, SVOCs, and VOCs. Two soil borings were drilled, and 11 subsurface samples were collected and screened for explosives in a field laboratory. Seven subsurface soil confirmatory samples were collected and analyzed for metals, hexavalent chromium, explosives, SVOCs, and VOCs. During Phase 2, two additional surface soil samples were collected from SS-16-6090 and analyzed for aluminum and lead.

Explosives and lead contaminated soils at Study Area 19 detected during the Supplemental RI (SAIC 1996a) were included for remediation in a 1996 IROD (Weston 1996b, 1996c). In 1996, Roy F. Weston conducted a sampling program to identify locations and quantify the extent of explosives and lead contamination. Screening and confirmatory samples were collected at five locations within Study Area 19 and the adjacent Study Area 16. Study Area 19 soil in the general area of Burning Pit 4 was identified for remediation. 2,4-DNT concentrations detected at Study Area 19 were less than 1 ppm; however, the maximum lead concentration detected was 566 ppm (Weston 1996b, 1996c). Because the Study Area 19 soils were contaminated with lead only, they were not incinerated, but left in place for future remediation.

Subsequent to Roy F. Weston's investigation, ECC conducted remediation for lead-contaminated soils at Study Area 19. **Figure 4-30** shows the area excavated by ECC. All lead-contaminated soils with concentrations in excess of 300 ppm were excavated and stabilized using an onsite pugmill (ECC 1998). Excavation confirmatory samples were collected after completion of excavation activities. A total of 1,500 cubic yards of lead-contaminated soil from Study Areas 16 and 19 were excavated and stabilized.

Appendix K presents the Supplemental RI data summary tables for Study Area 19. The remediation data collected by ECC are presented in Appendix L. For the purposes of statistical analysis, Supplemental RI data from locations that subsequently were remediated were removed from the data set. The post-excavation confirmatory data were included in the statistical analysis. Summary statistics for the soils remaining at Study Area 19 are shown in **Tables 4-50** through **4-52**. **Figure 4-31** shows the locations where the general contaminant group CEBs (metals, SVOCs, VOCs, and explosives) were detected in Supplemental RI samples in Study Area 19 soils remaining after remediation. Sheets 4-5 and 4-6 depict screening results for surface and subsurface samples collected from Study Area 19.

Metals—Five metals were detected in Study Area 19 surface soils at concentrations exceeding background. The metals and their maximum concentrations are listed in the adjacent box. Lead concentrations in soils ranged from nondetect (less than 10 µg/g) to 551 µg/g at surface soil location SS-19-5040. With the exception of the maximum detected

Maximum Concentrations*			
Analyte (µg/g)	0-<1ft**	1-10ft**	>10ft**
Arsenic		50.3	
Cadmium		0.733	
Chromium	107		
Lead	551	**250**	37.2
Zinc	40.6		

* Metals also determined to exceed background based on ANOVA evaluation are shown in bold.

** ANOVA evaluation was not conducted for any metals except lead because there are fewer than four samples in the data set.

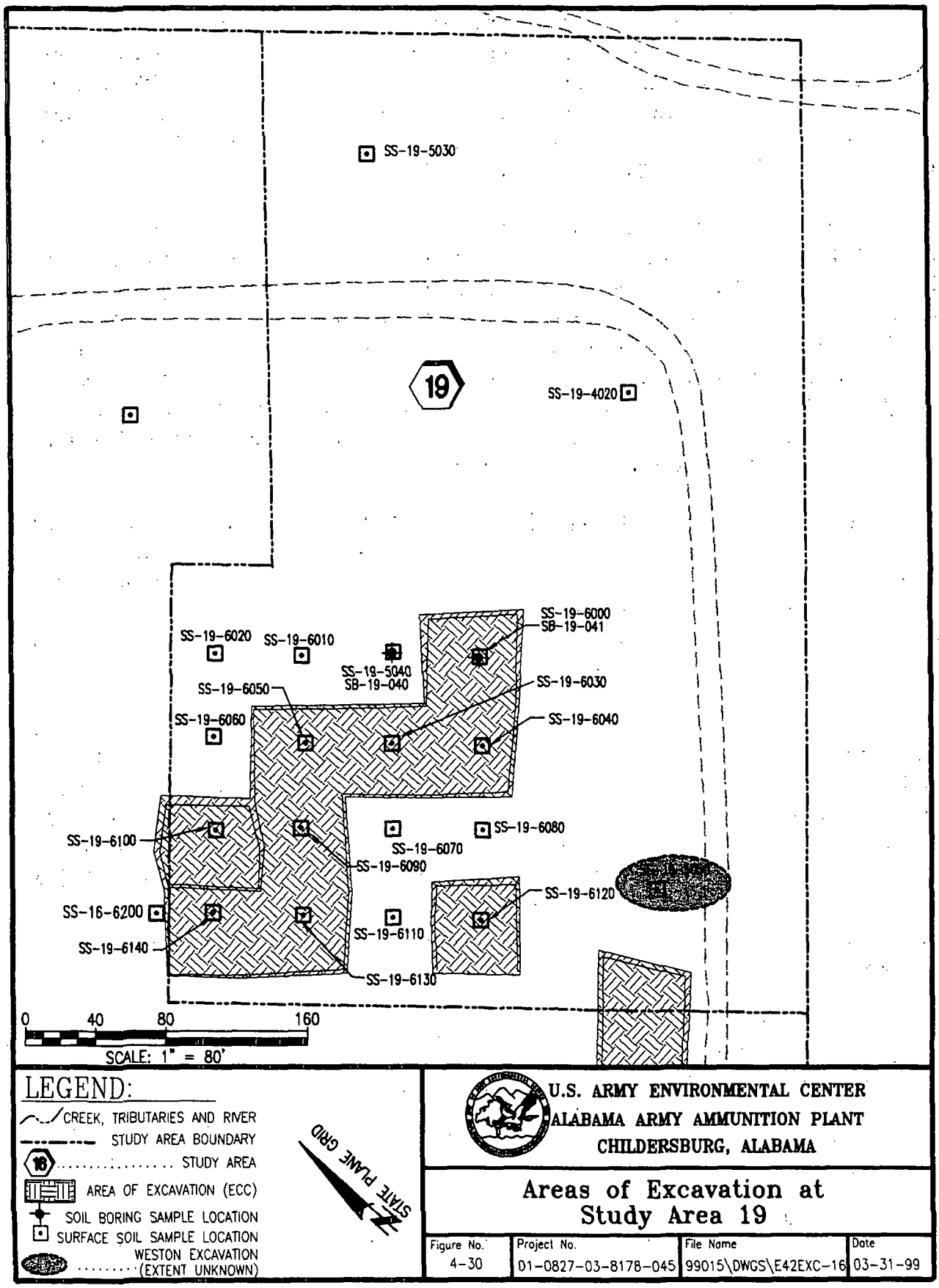

SS-19-5030
19
SS-19-4020
SS-19-6000
SB-19-041
SS-19-6020
SS-19-6010
SS-19-5040
SB-19-040
SS-19-6030
SS-19-6050
SS-19-6060
SS-19-6040
SS-19-6100
SS-19-6080
SS-19-6070
SS-19-6090
SS-19-6120
SS-16-6200
SS-19-6110
SS-19-6140
SS-19-6130
0 40 80 160
SCALE: 1" = 80'
LEGEND:
CREEK, TRIBUTARIES AND RIVER
STUDY AREA BOUNDARY
STUDY AREA
AREA OF EXCAVATION (ECC)
SOIL BORING SAMPLE LOCATION
SURFACE SOIL SAMPLE LOCATION
WESTON EXCAVATION
(EXTENT UNKNOWN)
STATE PLANE GRID
U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA
Areas of Excavation at
Study Area 19
Figure No. 4-30
Project No. 01-0827-03-8178-045
File Name 99015\DWGS\E42EXC-16
Date 03-31-99

Table 4-50. Summary Statistics and Exposure Point Concentrations for Soil (0-<1 ft BLS) at Study Area 19 - Lead Facility
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:02:46 PM
Run Date: 3/29/99
Exposure Unit: 19_SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	5 / 5	3 / 3	100%	--	--	10,000	17,000	--	--	Undetermined	--	17,000	#	20,277	[bk]
Barium	µg/g	5 / 5	3 / 3	100%	--	--	32	48	--	--	Undetermined	--	48	#	124	[bk]
Beryllium	µg/g	5 / 5	3 / 3	100%	--	--	0.32	0.43	--	--	Undetermined	--	0.43	#	0.82	[bk]
Calcium	µg/g	5 / 5	3 / 3	100%	--	--	137	511	--	--	Undetermined	--	511	#	4,960	[bk]
Chromium	µg/g	5 / 5	3 / 3	100%	--	--	21	107	--	--	Undetermined	--	107	#	54	[CEB]
Cobalt	µg/g	5 / 5	3 / 3	100%	--	--	3.2	5.3	--	--	Undetermined	--	5.3	#	14	[bk]
Copper	µg/g	5 / 5	3 / 3	100%	--	--	5.0	8.8	--	--	Undetermined	--	8.8	#	13	[bk]
Iron	µg/g	5 / 5	3 / 3	100%	--	--	13,000	27,000	--	--	Undetermined	--	27,000	#	37,560	[bk]
Lead	µg/g	75 / 83	74 / 81	91%	3.8	10.0	4.8	551	46	81	Lognormal	62	62		34	[CEB][ANOVA]
Magnesium	µg/g	5 / 5	3 / 3	100%	--	--	389	723	--	--	Undetermined	--	723	#	1,189	[bk]
Manganese	µg/g	5 / 5	3 / 3	100%	--	--	165	550	--	--	Undetermined	--	550	#	1,730	[bk]
Potassium	µg/g	5 / 5	3 / 3	100%	--	--	219	582	--	--	Undetermined	--	582	#	680	[bk]
Sodium	µg/g	1 / 5	1 / 3	33%	50	50	78	78	--	--	Undetermined	--	78	#	501	[bk]
Vanadium	µg/g	5 / 5	3 / 3	100%	--	--	24	57	--	--	Undetermined	--	57	#	76	[bk]
Zinc	µg/g	5 / 5	3 / 3	100%	--	--	25	41	--	--	Undetermined	--	41	#	36	[CEB]
Methylene Chloride	µg/g	2 / 2	2 / 2	100%	--	--	0.0040	0.0046	--	--	Undetermined	--	0.0046	#	--	[CEB]
Toluene	µg/g	1 / 2	1 / 2	50%	0.0025	0.0025	0.0025	0.0025	--	--	Undetermined	--	0.0025	#	--	[CEB]
Total Organic Carbon	µg/g	1 / 2	1 / 2	50%	1000	1000	19,900	19,900	--	--	Undetermined	--	19,900	#	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-51. Summary Statistics and Exposure Point Concentrations for Soil (1-10 ft BLS) at Study Area 19 - Lead Facility
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:02:46 PM
Run Date: 3/29/99
Exposure Unit: 19__SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	2 / 2	2 / 2	100%	--	--	10,000	24,000	--	--	Undetermined	--	24,000	#	27,733	[bk]
Arsenic	µg/g	1 / 2	1 / 2	50%	13	13	50	50	--	--	Undetermined	--	50	#	42	[CEB]
Barium	µg/g	2 / 2	2 / 2	100%	--	--	21	29	--	--	Undetermined	--	29	#	64	[bk]
Beryllium	µg/g	1 / 2	1 / 2	50%	0.25	0.25	0.38	0.38	--	--	Undetermined	--	0.38	#	0.80	[bk]
Cadmium	µg/g	1 / 2	1 / 2	50%	0.43	0.43	0.73	0.73	--	--	Undetermined	--	0.73	#	--	[CEB]
Calcium	µg/g	2 / 2	2 / 2	100%	--	--	132	254	--	--	Undetermined	--	254	#	2,475	[bk]
Chromium	µg/g	1 / 2	1 / 2	50%	70	70	40	40	--	--	Undetermined	--	40	#	46	[bk]
Cobalt	µg/g	1 / 2	1 / 2	50%	2.5	2.5	5.4	5.4	--	--	Undetermined	--	5.4	#	7.0	[bk]
Copper	µg/g	1 / 2	1 / 2	50%	3.4	3.4	8.2	8.2	--	--	Undetermined	--	8.2	#	26	[bk]
Iron	µg/g	2 / 2	2 / 2	100%	--	--	16,000	49,000	--	--	Undetermined	--	49,000	#	52,000	[bk]
Lead	µg/g	40 / 42	38 / 40	95%	10.0	10.0	5.0	250	26	29	Lognormal	33	33		14	[CEB]
Magnesium	µg/g	2 / 2	2 / 2	100%	--	--	320	401	--	--	Undetermined	--	401	#	1,399	[bk]
Manganese	µg/g	2 / 2	2 / 2	100%	--	--	119	142	--	--	Undetermined	--	142	#	682	[bk]
Potassium	µg/g	1 / 2	1 / 2	50%	142	142	178	178	--	--	Undetermined	--	178	#	1,324	[bk]
Vanadium	µg/g	2 / 2	2 / 2	100%	--	--	32	94	--	--	Undetermined	--	94	#	96	[bk]
Zinc	µg/g	2 / 2	2 / 2	100%	--	--	17	31	--	--	Undetermined	--	31	#	71	[bk]
Acetone	µg/g	1 / 2	1 / 2	50%	0.045	0.045	0.20	0.20	--	--	Undetermined	--	0.20	#	--	[CEB]
Toluene	µg/g	2 / 2	2 / 2	100%	--	--	0.0088	0.027	--	--	Undetermined	--	0.027	#	--	[CEB]
Total Organic Carbon	µg/g	2 / 2	2 / 2	100%	--	--	1,430	3,890	--	--	Undetermined	--	3,890	#	--	[CEB]

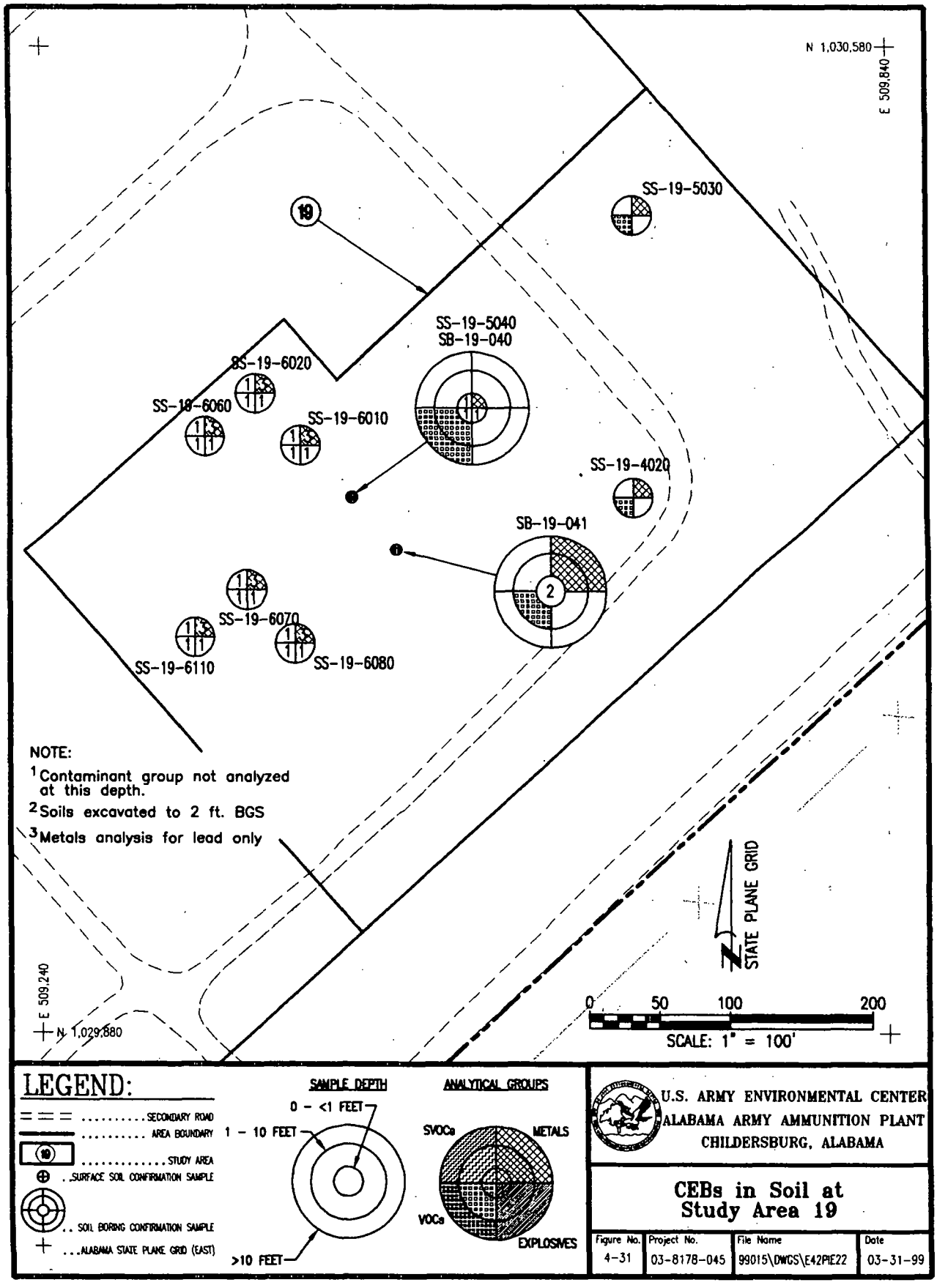
[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-52. Summary Statistics and Exposure Point Concentrations for Soil (>10 ft BLS) at Study Area 19 - Lead Facility
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:02:47 PM
Run Date: 3/29/99
Exposure Unit: 19_SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	2 / 2	2 / 2	100%	--	--	5,600	6,200	--	--	Undetermined	--	6,200	#	27,567	[bk]
Arsenic	µg/g	2 / 2	2 / 2	100%	--	--	28	29	--	--	Undetermined	--	29	#	52	[bk]
Barium	µg/g	2 / 2	2 / 2	100%	--	--	6.1	6.6	--	--	Undetermined	--	6.6	#	41	[bk]
Beryllium	µg/g	1 / 2	1 / 2	50%	0.25	0.25	0.57	0.57	--	--	Undetermined	--	0.57	#	0.89	[bk]
Chromium	µg/g	2 / 2	2 / 2	100%	--	--	18	21	--	--	Undetermined	--	21	#	53	[bk]
Cobalt	µg/g	2 / 2	2 / 2	100%	--	--	5.3	6.6	--	--	Undetermined	--	6.6	#	58	[bk]
Copper	µg/g	2 / 2	2 / 2	100%	--	--	15	23	--	--	Undetermined	--	23	#	56	[bk]
Iron	µg/g	2 / 2	2 / 2	100%	--	--	25,000	34,000	--	--	Undetermined	--	34,000	#	57,000	[bk]
Lead	µg/g	3 / 5	2 / 4	50%	10.0	10.0	14	37	13	10	Normal	25	25		32	[CEB][ANOVA]
Manganese	µg/g	2 / 2	2 / 2	100%	--	--	62	110	--	--	Undetermined	--	110	#	1,331	[bk]
Mercury	µg/g	1 / 2	1 / 2	50%	0.087	0.087	0.11	0.11	--	--	Undetermined	--	0.11	#	0.36	[bk]
Nickel	µg/g	2 / 2	2 / 2	100%	--	--	10	16	--	--	Undetermined	--	16	#	46	[bk]
Potassium	µg/g	2 / 2	2 / 2	100%	--	--	193	326	--	--	Undetermined	--	326	#	1,206	[bk]
Vanadium	µg/g	2 / 2	2 / 2	100%	--	--	36	48	--	--	Undetermined	--	48	#	92	[bk]
Zinc	µg/g	1 / 2	1 / 2	50%	43	43	59	59	--	--	Undetermined	--	59	#	104	[bk]
Toluene	µg/g	1 / 2	1 / 2	50%	0.0025	0.0025	0.0023	0.0023	--	--	Undetermined	--	0.0023	#	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)


N 1,030,580
E 509,840
SS-19-5030
19
SS-19-5040
SB-19-040
SS-19-6020
SS-19-6060
SS-19-6010
SS-19-4020
SB-19-041
2
SS-19-6070
SS-19-6110
SS-19-6080
NOTE:
1 Contaminant group not analyzed at this depth.
2 Soils excavated to 2 ft. BGS
3 Metals analysis for lead only
STATE PLANE GRID
E 509,240
N 1,029,880
0 50 100 200
SCALE: 1" = 100'
LEGEND:
SECONDARY ROAD
AREA BOUNDARY
STUDY AREA
SURFACE SOIL CONFIRMATION SAMPLE
SOIL BORING CONFIRMATION SAMPLE
ALABAMA STATE PLANE GRID (EAST)
SAMPLE DEPTH
0 - <1 FEET
1 - 10 FEET
>10 FEET
ANALYTICAL GROUPS
SVOCs
METALS
VOCs
EXPLOSIVES
U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA
CEBs in Soil at Study Area 19
Figure No. 4-31
Project No. 03-8178-045
File Name 99015\DWGS\E42PIE22
Date 03-31-99

concentration, all lead concentrations were less than 300 µg/g. In general, lead concentrations decreased with increasing sample depth.

Explosives—A surface soil sample was collected from one location (SS-19-5050) in the extreme southern corner of the study area and was screened for TNT in the field laboratory during Phase 1 (Sheet 4-5). TNT was not detected in the sample. In addition, 11 subsurface samples were collected from 2 soil borings drilled in the center of Study Area 19 and were screened for explosives. Explosives were detected at concentrations less than 5 µg/g in screening samples collected at depths of 15, 20, and 25 feet BLS from one of the borings (SB-19-040). Explosives were not detected in any of the laboratory confirmatory samples.

VOCs—Three VOCs were detected in soils at Study Area 19. The VOCs and their maximum concentrations are listed in the adjacent box. Toluene was detected in one surface, two shallow subsurface, and one deep soil sample at concentrations near or below the CRL. Acetone was detected in one shallow subsurface soil sample (SB-19-040; 1-foot BLS). Methylene chloride was detected in two surface soil samples at concentrations below the CRL.

Maximum Concentrations			
Analyte (µg/g)	0-<1ft	1-10ft	>10ft
Acetone		0.2	
Methylene Chloride	0.0046		
Toluene	<0.0025	0.027	0.0023

SVOCs—SVOCs were not detected in any of the Study Area 19 soil samples.

Summary—Metals and VOCs were detected in Study Area 19 soils. The results of the Phase 1 Supplemental RI indicated that lead was present in the Study Area 19 soils at concentrations in excess of excavation criteria. ECC excavated and stabilized lead-contaminated soils at Study Area 19. Sampling results from the soils remaining at Study Area 19 indicate that all lead concentrations, with the exception of one surface soil sample (SS-19-5040), are below ECC's excavation criterion of 300 ppm.

Results of VOC analyses do not indicate significant VOC contamination in the surface and subsurface soils. Explosives and SVOCs were not detected in Study Area 19 laboratory samples.

4.5.14 Study Area 20 – Rifle Powder Finishing Area

This study area is the Rifle Powder Finishing Area. The compounds used for the preparation of smokeless powder (diphenylamine, dibutyl phthalate, and 2,4-DNT) also were used in the production of rifle powder. The amounts of these additives varied based on the powder specifications. Although no other information on this process is available, the area may have been used for glazing. In this process, the dried powder is mixed with dry graphite to produce a black "glaze" coating on the surface. The purpose of this operation was to impart a conductive outer surface to dissipate static electricity (DA 1978). Soil samples collected during previous

investigations conducted at Study Area 20 identified the presence of significant concentrations of 2,4-DNT (ESE 1981).

During Phase 1 of the Supplemental RI, seven surface soil samples were collected and screened in the field for explosives. In addition, five surface soil samples were sent to the laboratory for confirmatory analysis. Two borings were placed in Study Area 20 and two samples from each boring were sent to the laboratory for analysis. All confirmatory samples were analyzed for metals, explosives, VOCs, and SVOCs. During Phase 2, one boring was drilled for collection of screening soil and in situ groundwater samples. The location of the soil boring during Phase 2 is shown on Sheet 4-6. A confirmatory sample was not collected.

Appendix K presents data summary tables for Study Area 20. **Tables 4-53** through **4-55** present summary statistics for Study Area 20 soils. **Figure 4-32** shows the locations where the general contaminant group CEBs (metals, SVOCs, VOCs, and explosives) were detected in Study Area 20 soils. The lack of quadrants in a circle indicates that a soil sample was not collected at that interval. Sheets 4-5 and 4-6 present the screening results for surface and subsurface soils.

Metals—Fifteen metals were detected at concentrations above background in Study Area 20 soils, as shown in the adjacent box. In general, metals concentrations increased with increasing sample depth. Nine metals were detected at concentrations exceeding background in the surface soil horizon. Seven metals exceeded background concentrations in the shallow subsurface. The maximum concentrations of barium and cobalt in shallow subsurface soils were detected at SB-20-043, while location SB-20-044 contained the maximum concentrations of aluminum, iron, lead, and vanadium detected in the shallow subsurface. Ten metals were detected at concentrations exceeding background levels in the deep soil horizon. The maximum concentrations of iron, lead, and vanadium in the deep subsurface soils were detected at SB-20-043. Maximum concentrations of aluminum, barium, beryllium, and manganese were detected at SB-20-044. Lead concentrations in Study Area 20 soils varied within a narrow range, from nondetect in the surface soils at SS-20-1020 to a concentration of 48.6 µg/g at 25 feet BLS at SB-20-043.

	Maximum Concentrations*		
Analyte (µg/g)	0-<1ft	1-10ft**	>10ft**
Aluminum	24,000	48,000	290,000
Arsenic	20.6		
Barium	141	63.7	175
Beryllium	1.11		6.14
Calcium	9,300		2,060
Chromium	87.3		
Cobalt		15.8	
Iron		55,000	73,000
Lead		25.5	48.6
Magnesium	1,530		1,450
Manganese			2,700
Nickel	11.1		
Potassium	92.6		
Sodium		75.4	79.3
Vanadium		126	148

* Metals also determined to exceed background based on ANOVA evaluation are shown in bold.

** ANOVA evaluation not conducted because there are fewer than four samples in the data set.

Table 4-53. Summary Statistics and Exposure Point Concentrations for Soil (0-<1 ft BLS) at Study Area 20 - Rifle Powder Finishing Area
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:05:12 PM
Run Date: 3/29/99
Exposure Unit: 20_SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	5 / 5	5 / 5	100%	--	--	11,000	24,000	17,600	5,079	Normal	22,443	22,443		20,277	[CEB][ANOVA]
Arsenic	µg/g	3 / 5	3 / 5	60%	13	13	17	21	14	7.2	Normal	21	21	#	15	[CEB][ANOVA]
Barium	µg/g	5 / 5	5 / 5	100%	--	--	100	141	112	17	Lognormal	130	130		124	[CEB][ANOVA]
Beryllium	µg/g	5 / 5	5 / 5	100%	--	--	0.42	1.1	0.72	0.26	Normal	0.98	0.98		0.82	[CEB][ANOVA]
Calcium	µg/g	5 / 5	5 / 5	100%	--	--	911	9,300	2,653	3,716	Lognormal	30,242	9,300	#	4,960	[CEB][ANOVA]
Chromium	µg/g	5 / 5	5 / 5	100%	--	--	16	87	40	28	Normal	66	66		54	[CEB][ANOVA]
Copper	µg/g	5 / 5	5 / 5	100%	--	--	6.3	12	9.2	2.2	Normal	11	11		13	[bk]
Iron	µg/g	5 / 5	5 / 5	100%	--	--	18,000	37,000	27,800	7,463	Normal	34,915	34,915		37,560	[bk]
Lead	µg/g	4 / 5	4 / 5	80%	10.0	10.0	23	28	22	9.5	Lognormal	98	28	#	34	[bk]
Magnesium	µg/g	5 / 5	5 / 5	100%	--	--	402	1,530	787	442	Normal	1,208	1,208		1,189	[CEB][ANOVA]
Manganese	µg/g	5 / 5	5 / 5	100%	--	--	760	1,200	966	182	Normal	1,139	1,139		1,730	[bk]
Nickel	µg/g	2 / 5	2 / 5	40%	7.5	7.5	11	11	6.6	3.9	Lognormal	17	11	#	9.4	[CEB][ANOVA]
Potassium	µg/g	5 / 5	5 / 5	100%	--	--	312	926	562	264	Normal	814	814		680	[CEB][ANOVA]
Sodium	µg/g	1 / 5	1 / 5	20%	50	50	88	88	38	28	Lognormal	92	88	#	501	[bk]
Vanadium	µg/g	5 / 5	5 / 5	100%	--	--	38	74	56	14	Normal	69	69		76	[bk]
2,4-Dinitrotoluene	µg/g	5 / 5	5 / 5	100%	--	--	0.42	1.1	0.64	0.29	Normal	0.91	0.91		--	[CEB]
Fluoranthene	µg/g	1 / 5	1 / 5	20%	0.17	0.17	0.92	0.92	0.25	0.37	Lognormal	3.8	0.92	#	--	[CEB]
Toluene	µg/g	3 / 5	3 / 5	60%	0.0025	0.0025	0.0026	0.0079	0.0034	0.0028	Normal	0.0060	0.0060		--	[CEB]
Total Organic Carbon	µg/g	5 / 5	5 / 5	100%	--	--	15,600	35,600	28,000	8,510	Normal	36,113	35,600	#	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-54. Summary Statistics and Exposure Point Concentrations for Soil (1-10 ft BLS) at Study Area 20 - Rifle Powder Finishing Area
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:05:12 PM
Run Date: 3/29/99
Exposure Unit: 20_SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	2 / 2	2 / 2	100%	--	--	41,000	48,000	--	--	Undetermined	--	48,000	#	27,733	[CEB]
Arsenic	µg/g	1 / 2	1 / 2	50%	13	13	24	24	--	--	Undetermined	--	24	#	42	[bk]
Barium	µg/g	2 / 2	2 / 2	100%	--	--	32	64	--	--	Undetermined	--	64	#	64	[CEB]
Beryllium	µg/g	2 / 2	2 / 2	100%	--	--	0.65	0.66	--	--	Undetermined	--	0.66	#	0.80	[bk]
Calcium	µg/g	2 / 2	2 / 2	100%	--	--	537	1,620	--	--	Undetermined	--	1,620	#	2,475	[bk]
Cobalt	µg/g	1 / 2	1 / 2	50%	2.5	2.5	16	16	--	--	Undetermined	--	16	#	7.0	[CEB]
Copper	µg/g	2 / 2	2 / 2	100%	--	--	17	18	--	--	Undetermined	--	18	#	26	[bk]
Iron	µg/g	2 / 2	2 / 2	100%	--	--	43,000	55,000	--	--	Undetermined	--	55,000	#	52,000	[CEB]
Lead	µg/g	2 / 2	2 / 2	100%	--	--	23	26	--	--	Undetermined	--	26	#	14	[CEB]
Magnesium	µg/g	2 / 2	2 / 2	100%	--	--	751	1,230	--	--	Undetermined	--	1,230	#	1,399	[bk]
Manganese	µg/g	2 / 2	2 / 2	100%	--	--	420	570	--	--	Undetermined	--	570	#	682	[bk]
Nickel	µg/g	2 / 2	2 / 2	100%	--	--	13	18	--	--	Undetermined	--	18	#	21	[bk]
Potassium	µg/g	2 / 2	2 / 2	100%	--	--	435	1,200	--	--	Undetermined	--	1,200	#	1,324	[bk]
Sodium	µg/g	2 / 2	2 / 2	100%	--	--	62	75	--	--	Undetermined	--	75	#	--	[CEB]
Vanadium	µg/g	2 / 2	2 / 2	100%	--	--	97	126	--	--	Undetermined	--	126	#	96	[CEB]
Zinc	µg/g	1 / 2	1 / 2	50%	69	69	52	52	--	--	Undetermined	--	52	#	71	[bk]
2,4-Dinitrotoluene	µg/g	1 / 2	1 / 2	50%	0.056	0.056	0.39	0.39	--	--	Undetermined	--	0.39	#	--	[CEB]
Methylene Chloride	µg/g	1 / 2	1 / 2	50%	0.0062	0.0062	0.0055	0.0055	--	--	Undetermined	--	0.0055	#	--	[CEB]
Toluene	µg/g	1 / 2	1 / 2	50%	0.0025	0.0025	0.0022	0.0022	--	--	Undetermined	--	0.0022	#	--	[CEB]
Total Organic Carbon	µg/g	2 / 2	2 / 2	100%	--	--	2,300	4,090	--	--	Undetermined	--	4,090	#	--	[CEB]

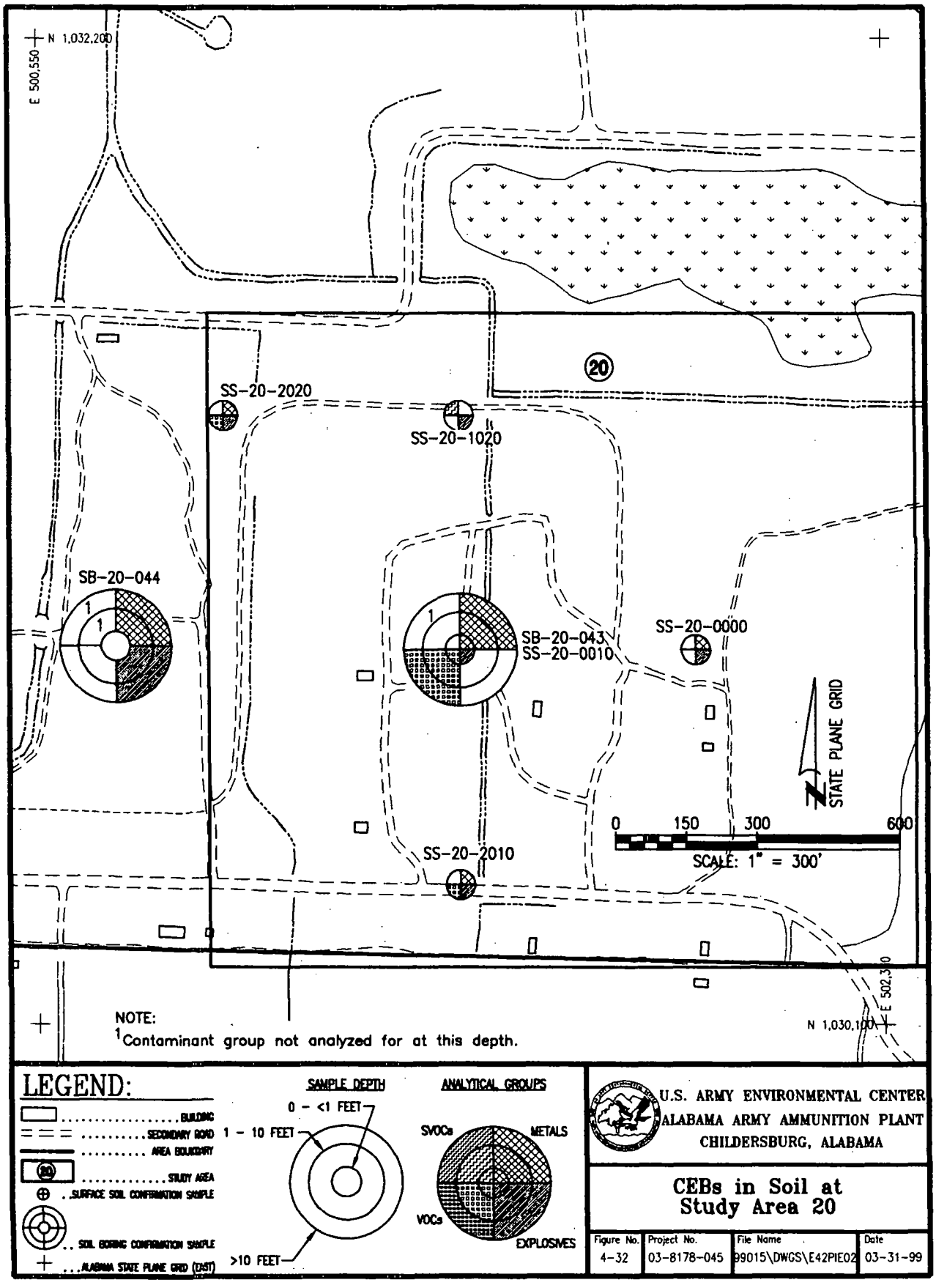
[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-55. Summary Statistics and Exposure Point Concentrations for Soil (>10 ft BLS) at Study Area 20 - Rifle Powder Finishing Area
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:05:12 PM
Run Date: 3/29/99
Exposure Unit: 20_SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	2 / 2	2 / 2	100%	--	--	19,000	290,000	--	--	Undetermined	--	290,000	#	27,567	[CEB]
Arsenic	µg/g	2 / 2	2 / 2	100%	--	--	21	24	--	--	Undetermined	--	24	#	52	[bk]
Barium	µg/g	2 / 2	2 / 2	100%	--	--	26	175	--	--	Undetermined	--	175	#	41	[CEB]
Beryllium	µg/g	2 / 2	2 / 2	100%	--	--	0.78	6.1	--	--	Undetermined	--	6.1	#	0.89	[CEB]
Calcium	µg/g	2 / 2	2 / 2	100%	--	--	781	2,060	--	--	Undetermined	--	2,060	#	257	[CEB]
Cobalt	µg/g	1 / 2	1 / 2	50%	2.5	2.5	4.4	4.4	--	--	Undetermined	--	4.4	#	58	[bk]
Copper	µg/g	2 / 2	2 / 2	100%	--	--	23	25	--	--	Undetermined	--	25	#	56	[bk]
Iron	µg/g	2 / 2	2 / 2	100%	--	--	59,000	73,000	--	--	Undetermined	--	73,000	#	57,000	[CEB]
Lead	µg/g	2 / 2	2 / 2	100%	--	--	23	49	--	--	Undetermined	--	49	#	32	[CEB]
Magnesium	µg/g	2 / 2	2 / 2	100%	--	--	510	1,450	--	--	Undetermined	--	1,450	#	867	[CEB]
Manganese	µg/g	2 / 2	2 / 2	100%	--	--	750	2,700	--	--	Undetermined	--	2,700	#	1,331	[CEB]
Mercury	µg/g	1 / 2	1 / 2	50%	0.087	0.087	0.18	0.18	--	--	Undetermined	--	0.18	#	0.36	[bk]
Nickel	µg/g	2 / 2	2 / 2	100%	--	--	15	34	--	--	Undetermined	--	34	#	46	[bk]
Potassium	µg/g	2 / 2	2 / 2	100%	--	--	267	378	--	--	Undetermined	--	378	#	1,206	[bk]
Sodium	µg/g	1 / 2	1 / 2	50%	50	50	79	79	--	--	Undetermined	--	79	#	--	[CEB]
Vanadium	µg/g	2 / 2	2 / 2	100%	--	--	70	148	--	--	Undetermined	--	148	#	92	[CEB]
Zinc	µg/g	1 / 2	1 / 2	50%	42	42	80	80	--	--	Undetermined	--	80	#	104	[bk]
2,4-Dinitrotoluene	µg/g	1 / 2	1 / 2	50%	0.056	0.056	0.14	0.14	--	--	Undetermined	--	0.14	#	--	[CEB]
Methylene Chloride	µg/g	1 / 2	1 / 2	50%	0.0062	0.0062	0.0074	0.0074	--	--	Undetermined	--	0.0074	#	--	[CEB]
Total Organic Carbon	µg/g	1 / 2	1 / 2	50%	1000	1000	1,930	1,930	--	--	Undetermined	--	1,930	#	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)


N 1,032,200
E 500,550
20
SS-20-2020
SS-20-1020
SB-20-044
1
1
1
SB-20-043
SS-20-0010
SS-20-0000
STATE PLANE GRID
0
150
300
600
SCALE: 1" = 300'
SS-20-2010
E 502,300
N 1,030,100
NOTE:
1Contaminant group not analyzed for at this depth.
LEGEND:
BUILDING
SECONDARY ROAD
AREA BOUNDARY
STUDY AREA
SURFACE SOIL CONFIRMATION SAMPLE
SOIL BORING CONFIRMATION SAMPLE
ALABAMA STATE PLANE GRID (EAST)
SAMPLE DEPTH
0 - <1 FEET
1 - 10 FEET
>10 FEET
ANALYTICAL GROUPS
SVOCs
METALS
VOCs
EXPLOSIVES
U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA
CEBs in Soil at
Study Area 20
Figure No. 4-32
Project No. 03-8178-045
File Name 99015\DWGS\E42PIE02
Date 03-31-99

Explosives—Explosives were not detected in any of the seven surface soil samples collected for field screening. Explosives (13 ppm) were detected in the Phase 2 boring sample that was screened onsite, but not at a concentration that would indicate the presence of a significant contamination source. Laboratory confirmatory results indicated the presence of 2,4-DNT in all five surface soil samples and in both samples from the boring at location SB-20-044. The highest concentration of 2,4-DNT (1.13 µg/g) was detected at surface sample location SS-20-2020 along the northern edge of the study area (see adjacent box). Other detected concentrations were lower and distributed throughout the site (see Sheet 4-8). Concentrations of 2,4-DNT detected in the surface soils at Study Area 20 ranged from 0.42 to 1.13 µg/g.

Maximum Concentrations			
Analyte (µg/g)	0-<1ft	1-10ft	>10ft
2,4-DNT	1.13	0.39	0.135

2,4-DNT also was detected in two subsurface soil samples collected from soil boring SB-20-044, drilled at the western boundary of the study area. 2,4-DNT was detected at depths of 1 foot and 20 feet BLS at concentrations of 0.39 and 0.135 µg/g, respectively. Explosives were not detected in the subsurface soils at soil boring location SB-20-043.

VOCs—Two VOCs were detected in soils at concentrations near or below the CRL. The VOCs and maximum concentrations are listed in the adjacent box.

Maximum Concentrations			
Analyte (µg/g)	0-<1ft	1-10ft	>10ft
Methylene Chloride		0.0055	0.0074
Toluene	0.0079	0.0022	

SVOCs—Fluoranthene was detected at a concentration of 0.92 µg/g in surface soil sample SS-20-1020. No other SVOCs were detected in soils from Study Area 20.

Summary—Fifteen metals, one explosive compound (2,4-DNT), two VOCs, and fluoranthene were detected in the soils at Study Area 20 at concentrations exceeding background. Concentrations of 2,4-DNT that ranged from 0.42 to 1.13 µg/g were detected in each of the surface soil samples collected. Relatively low concentrations of 2,4-DNT (0.135 to 0.39 µg/g) also were detected in the subsurface soils. The presence of 2,4-DNT in the soils is attributed to the former use of the site as a finishing area for rifle powder. The detected VOCs and SVOC are present at concentrations near or below the CRL.

4.5.15 Study Area 22 – Demolition Landfill

The Demolition Landfill, located near the Flashing Ground, consists of a semicircular landfill in a swale extending approximately 500 feet along Patrol Road. Rubble from demolition activities was dumped in a 50-foot-wide semicircle around the edge of the swale to an average depth of approximately 7 feet. Several hundred pounds of lead were found on the surface at this site in the form of sheets, wire, and pipe. Large amounts of cast iron, stainless steel fittings, aluminum, transite, and other rubble were partially buried by concrete and earth. Friable asbestos

also was distributed in the soil of this area. Previous soil sampling identified lead residues in concentrations above background in two samples and low concentrations of tetryl (ESE 1981).

Six soil sampling locations were established at Study Area 22 during Phase 1 of the Supplemental RI. Surface soil samples were collected from all six sampling locations and screened for lead on a quick-turnaround basis at the offsite laboratory (see Sheet 4-5). Three surface soil samples were submitted for confirmatory analysis, which included metals, explosives, VOCs, and SVOCs. Soil borings were drilled at three sampling locations. Metal and heavy debris were encountered during subsurface drilling. Fifteen subsurface soil samples were collected from the three borings and were analyzed for lead on a quick-turnaround basis. Nine shallow subsurface samples collected from all three borings and six deep subsurface soil samples collected from two of the borings were submitted for confirmatory analysis. All soil samples submitted for confirmatory analysis were analyzed for metals, explosives, VOCs, and SVOCs. Four samples (two surface and two subsurface) were analyzed for hexavalent chromium. During Phase 2, two additional surface soil samples were collected from location SS-22-003 and analyzed at the laboratory for aluminum and lead.

Appendix K presents data summary tables for Study Area 22. **Tables 4-56** through **4-58** present summary statistics for Study Area 22 soils. **Figure 4-33** shows the locations where the general contaminant group CEBs (metals, SVOCs, VOCs, and explosives) were detected in Study Area 22 soils. Sheets 4-5 and 4-6 present screening results for surface and subsurface soils, respectively, at Study Area 22.

Metals—Eighteen metals were detected in Study Area 22 soils at concentrations exceeding background. The metals and their maximum concentrations in each soil interval where concentrations exceeded background are listed in the adjacent box.

Maximum Concentrations*			
Analyte (µg/g)	0-<1ft**	1-10ft	>10ft**
Arsenic		44.1	
Barium	1,300	1,100	
Beryllium	0.959	1.21	1.47
Cadmium	11.9	**18.4**	
Calcium	11,000	20,000	
Chromium	95.8	259	
Cobalt		11.7	
Copper	1,020	2,800	
Iron		110,000	
Lead	**4,600**	**15,000**	125
Magnesium	10,000	2,190	
Manganese		1,900	
Mercury	0.47	2.1	
Molybdenum		**9.3**	
Nickel	95.8	259	55
Potassium	1,620	2,050	
Sodium		**588**	
Zinc	4,300	5,500	

* Metals also determined to exceed background based on ANOVA evaluation are shown in bold.

** ANOVA evaluation not conducted for any metals except lead because there are fewer than four samples in the data set.

The maximum concentrations of barium, cadmium, chromium, copper, lead, mercury, nickel, and zinc in surface soils all were detected at SS-22-003. Shallow subsurface soil detections of cadmium, lead, and molybdenum were highest at SB-22-048. The maximum concentrations of beryllium and nickel in deep subsurface soils were detected at SB-22-049.

Concentrations of barium in Study Area 22 surface soils (1,300 µg/g) were the highest

Table 4-56. Summary Statistics and Exposure Point Concentrations for Soil (0-<1 ft BLS) at Study Area 22 - Demolition Landfill
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:15:57 PM
Run Date: 3/29/99
Exposure Unit: 22__SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	5 / 5	3 / 3	100%	--	--	10,500	19,000	--	--	Undetermined	--	19,000	#	20,277	[bk]
Barium	µg/g	3 / 3	3 / 3	100%	--	--	30	1,300	--	--	Undetermined	--	1,300	#	124	[CEB]
Beryllium	µg/g	3 / 3	3 / 3	100%	--	--	0.33	0.96	--	--	Undetermined	--	0.96	#	0.82	[CEB]
Cadmium	µg/g	1 / 3	1 / 3	33%	0.43	0.43	12	12	--	--	Undetermined	--	12	#	--	[CEB]
Calcium	µg/g	3 / 3	3 / 3	100%	--	--	248	11,000	--	--	Undetermined	--	11,000	#	4,960	[CEB]
Chromium	µg/g	3 / 3	3 / 3	100%	--	--	18	96	--	--	Undetermined	--	96	#	54	[CEB]
Cobalt	µg/g	2 / 3	2 / 3	67%	2.5	2.5	7.2	12	--	--	Undetermined	--	12	#	14	[bk]
Copper	µg/g	3 / 3	3 / 3	100%	--	--	11	1,020	--	--	Undetermined	--	1,020	#	13	[CEB]
Iron	µg/g	3 / 3	3 / 3	100%	--	--	16,000	26,000	--	--	Undetermined	--	26,000	#	37,560	[bk]
Lead	µg/g	11 / 11	6 / 6	100%	--	--	12	4,600	1,310	1,693	Normal	2,703	2,703		34	[CEB]
Magnesium	µg/g	3 / 3	3 / 3	100%	--	--	669	10,000	--	--	Undetermined	--	10,000	#	1,189	[CEB]
Manganese	µg/g	3 / 3	3 / 3	100%	--	--	137	1,600	--	--	Undetermined	--	1,600	#	1,730	[bk]
Mercury	µg/g	1 / 3	1 / 3	33%	0.087	0.087	0.47	0.47	--	--	Undetermined	--	0.47	#	0.056	[CEB]
Nickel	µg/g	2 / 3	2 / 3	67%	7.5	7.5	8.9	96	--	--	Undetermined	--	96	#	9.4	[CEB]
Potassium	µg/g	3 / 3	3 / 3	100%	--	--	738	1,620	--	--	Undetermined	--	1,620	#	680	[CEB]
Sodium	µg/g	1 / 3	1 / 3	33%	50	50	428	428	--	--	Undetermined	--	428	#	501	[bk]
Vanadium	µg/g	3 / 3	3 / 3	100%	--	--	29	46	--	--	Undetermined	--	46	#	76	[bk]
Zinc	µg/g	3 / 3	3 / 3	100%	--	--	36	4,300	--	--	Undetermined	--	4,300	#	36	[CEB]
Acetone	µg/g	1 / 3	1 / 3	33%	0.045	0.045	0.026	0.026	--	--	Undetermined	--	0.026	#	--	[CEB]
Methylene Chloride	µg/g	1 / 3	1 / 3	33%	0.0062	0.0062	0.0048	0.0048	--	--	Undetermined	--	0.0048	#	--	[CEB]
Toluene	µg/g	2 / 3	2 / 3	67%	0.0025	0.0025	0.0047	0.0049	--	--	Undetermined	--	0.0049	#	--	[CEB]
Total Organic Carbon	µg/g	3 / 3	3 / 3	100%	--	--	19,300	38,900	--	--	Undetermined	--	38,900	#	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-57. Summary Statistics and Exposure Point Concentrations for Soil (1-10 ft BLS) at Study Area 22 - Demolition Landfill
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:15:57 PM
Run Date: 3/29/99
Exposure Unit: 22_SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	7 / 7	7 / 7	100%	--	--	7,900	17,000	12,557	3,231	Normal	14,930	14,930		27,733	[bk]
Arsenic	µg/g	5 / 7	5 / 7	71%	13	13	17	44	27	16	Normal	39	39		42	[CEB][ANOVA]
Barium	µg/g	7 / 7	7 / 7	100%	--	--	22	1,100	272	402	Lognormal	5,872	1,100	#	64	[CEB][ANOVA]
Beryllium	µg/g	7 / 7	7 / 7	100%	--	--	0.38	1.2	0.61	0.28	Lognormal	0.87	0.87		0.80	[CEB][ANOVA]
Cadmium	µg/g	2 / 7	2 / 7	29%	0.43	0.43	2.4	18	3.1	6.8	Lognormal	218	18	#	--	[CEB]
Calcium	µg/g	6 / 7	6 / 7	86%	109	109	281	20,000	4,026	7,244	Lognormal	979,705	20,000	#	2,475	[CEB][ANOVA]
Chromium	µg/g	6 / 7	6 / 7	86%	47	47	13	259	54	91	Lognormal	250	250		46	[CEB][ANOVA]
Cobalt	µg/g	5 / 7	5 / 7	71%	2.5	2.5	6.1	12	7.0	4.3	Normal	10	10		7.0	[CEB][ANOVA]
Copper	µg/g	7 / 7	7 / 7	100%	--	--	5.6	2,800	465	1,036	Lognormal	416,683	2,800	#	26	[CEB][ANOVA]
Iron	µg/g	7 / 7	7 / 7	100%	--	--	14,000	110,000	38,000	32,726	Lognormal	82,457	82,457		52,000	[CEB][ANOVA]
Lead	µg/g	7 / 9	7 / 9	78%	10.0	10.0	21	15,000	2,281	5,065	Lognormal	1.35E+07	15,000	#	14	[CEB]
Magnesium	µg/g	6 / 7	6 / 7	86%	14,000	14,000	340	2,190	1,773	2,399	Lognormal	11,240	2,190	#	1,399	[CEB][ANOVA]
Manganese	µg/g	7 / 7	7 / 7	100%	--	--	50	1,900	873	628	Normal	1,334	1,334		682	[CEB][ANOVA]
Mercury	µg/g	4 / 7	4 / 7	57%	0.087	0.087	0.096	2.1	0.40	0.76	Lognormal	6.9	2.1	#	0.12	[CEB][ANOVA]
Molybdenum	µg/g	2 / 7	2 / 7	29%	4.0	4.0	7.1	9.3	3.8	3.1	Lognormal	8.5	8.5		--	[CEB]
Nickel	µg/g	4 / 7	4 / 7	57%	7.5	7.5	12	259	48	94	Lognormal	1,386	259	#	21	[CEB][ANOVA]
Potassium	µg/g	7 / 7	7 / 7	100%	--	--	288	2,050	809	684	Lognormal	2,127	2,050	#	1,324	[CEB][ANOVA]
Sodium	µg/g	4 / 7	4 / 7	57%	50	50	65	588	140	204	Lognormal	1,166	588	#	--	[CEB]
Vanadium	µg/g	7 / 7	7 / 7	100%	--	--	21	53	36	11	Normal	44	44		96	[bk]
Zinc	µg/g	3 / 7	3 / 7	43%	20	81	189	5,500	979	2,028	Lognormal	3.78E+06	5,500	#	71	[CEB][ANOVA]
2,4,6-Trinitrotoluene	µg/g	1 / 7	1 / 7	14%	0.089	0.089	0.21	0.21	0.068	0.062	Lognormal	0.12	0.12		--	[CEB]
2,4-Dinitrotoluene	µg/g	1 / 7	1 / 7	14%	0.056	0.056	0.13	0.13	0.042	0.037	Lognormal	0.074	0.074		--	[CEB]
2-Methylnaphthalene	µg/g	1 / 7	1 / 7	14%	0.17	0.17	30	30	4.4	11	Lognormal	3,607	30	#	--	[CEB]
Acenaphthene	µg/g	1 / 7	1 / 7	14%	0.27	0.27	100	100	14	38	Lognormal	66,349	100	#	--	[CEB]
Anthracene	µg/g	1 / 7	1 / 7	14%	0.17	0.17	200	200	29	76	Lognormal	2.41E+06	200	#	--	[CEB]
Benzo(a)anthracene	µg/g	3 / 7	3 / 7	43%	0.17	0.17	0.13	90	13	34	Lognormal	100,471	90	#	--	[CEB]
Benzo(a)pyrene	µg/g	1 / 7	1 / 7	14%	0.24	0.24	100	100	14	38	Lognormal	87,030	100	#	--	[CEB]
Benzo(b)fluoranthene	µg/g	1 / 7	1 / 7	14%	0.73	0.73	50,000	50,000	7,143	18,898	Lognormal	1.95E+16	50,000	#	--	[CEB]
Benzo(g,h,i)perylene	µg/g	1 / 7	1 / 7	14%	0.25	0.25	5,000	5,000	714	1,890	Lognormal	4.06E+12	5,000	#	--	[CEB]
Benzo(k)fluoranthene	µg/g	1 / 7	1 / 7	14%	0.40	0.40	700	700	100	264	Lognormal	2.89E+07	700	#	--	[CEB]
Chrysene	µg/g	1 / 7	1 / 7	14%	0.27	0.27	400	400	57	151	Lognormal	9.40E+06	400	#	--	[CEB]
Dibenzo(a,h)anthracene	µg/g	1 / 7	1 / 7	14%	0.27	0.27	300	300	43	113	Lognormal	3.09E+06	300	#	--	[CEB]
Dibenzofuran	µg/g	1 / 7	1 / 7	14%	0.17	0.17	80	80	12	30	Lognormal	92,682	80	#	--	[CEB]
Fluoranthene	µg/g	1 / 7	1 / 7	14%	0.17	0.17	300	300	43	113	Lognormal	1.27E+07	300	#	--	[CEB]
Fluorene	µg/g	1 / 7	1 / 7	14%	0.17	0.17	100	100	14	38	Lognormal	198,732	100	#	--	[CEB]
Indeno(1,2,3-cd)pyrene	µg/g	1 / 7	1 / 7	14%	0.17	0.17	1000	1000	143	378	Lognormal	3.83E+09	1000	#	--	[CEB]
Methylene Chloride	µg/g	6 / 8	6 / 8	75%	0.0062	0.0062	0.0043	0.0069	0.0047	0.0014	Normal	0.0057	0.0057		--	[CEB]
Naphthalene	µg/g	1 / 7	1 / 7	14%	0.17	0.17	80	80	12	30	Lognormal	92,682	80	#	--	[CEB]
Phenanthrene	µg/g	1 / 7	1 / 7	14%	0.17	0.17	1000	1000	143	378	Lognormal	3.83E+09	1000	#	--	[CEB]
Pyrene	µg/g	1 / 7	1 / 7	14%	0.97	0.97	1000	1000	143	378	Lognormal	8.42E+06	1000	#	--	[CEB]
Toluene	µg/g	5 / 8	5 / 8	63%	0.0025	0.0025	0.0021	0.052	0.0094	0.017	Lognormal	0.064	0.052	#	--	[CEB]
Total Organic Carbon	µg/g	4 / 7	4 / 7	57%	1000	1000	6,470	46,200	10,174	16,330	Lognormal	1.60E+06	46,200	#	--	[CEB]

Table 4-57. Summary Statistics and Exposure Point Concentrations for Soil (1-10 ft BLS) at Study Area 22 - Demolition Landfill (Continued)
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:15:57 PM
Run Date: 3/29/99
Exposure Unit: 22__SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]	2 x BK Mean[d]	Background Comparison[g]

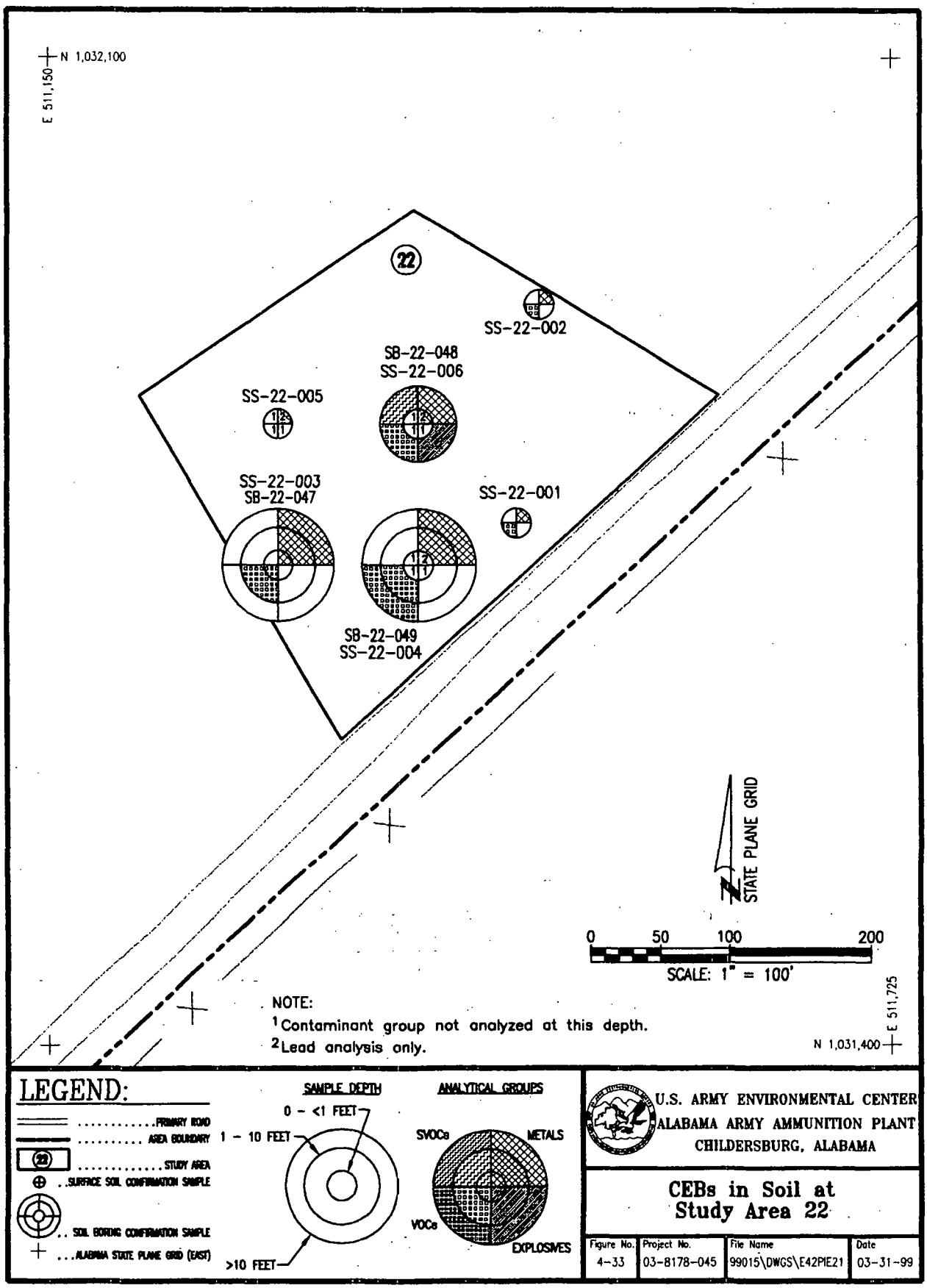
[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-58. Summary Statistics and Exposure Point Concentrations for Soil (>10 ft BLS) at Study Area 22 - Demolition Landfill
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:15:57 PM
Run Date: 3/29/99
Exposure Unit: 22__SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	2 / 2	2 / 2	100%	--	--	2,400	4,790	--	--	Undetermined	--	4,790	#	27,567	[bk]
Arsenic	µg/g	1 / 2	1 / 2	50%	13	13	41	41	--	--	Undetermined	--	41	#	52	[bk]
Barium	µg/g	2 / 2	2 / 2	100%	--	--	7.7	8.3	--	--	Undetermined	--	8.3	#	41	[bk]
Beryllium	µg/g	2 / 2	2 / 2	100%	--	--	1.3	1.5	--	--	Undetermined	--	1.5	#	0.89	[CEB]
Chromium	µg/g	2 / 2	2 / 2	100%	--	--	7.5	10.0	--	--	Undetermined	--	10.0	#	53	[bk]
Cobalt	µg/g	1 / 2	1 / 2	50%	2.5	2.5	7.0	7.0	--	--	Undetermined	--	7.0	#	58	[bk]
Copper	µg/g	2 / 2	2 / 2	100%	--	--	23	36	--	--	Undetermined	--	36	#	56	[bk]
Iron	µg/g	2 / 2	2 / 2	100%	--	--	34,000	36,000	--	--	Undetermined	--	36,000	#	57,000	[bk]
Lead	µg/g	2 / 6	2 / 6	33%	10.0	10.0	87	125	39	54	Lognormal	3,578	125	#	32	[CEB][ANOVA]
Magnesium	µg/g	1 / 2	1 / 2	50%	138	138	262	262	--	--	Undetermined	--	262	#	867	[bk]
Manganese	µg/g	2 / 2	2 / 2	100%	--	--	107	198	--	--	Undetermined	--	198	#	1,331	[bk]
Mercury	µg/g	1 / 2	1 / 2	50%	0.087	0.087	0.13	0.13	--	--	Undetermined	--	0.13	#	0.36	[bk]
Nickel	µg/g	2 / 2	2 / 2	100%	--	--	36	55	--	--	Undetermined	--	55	#	46	[CEB]
Potassium	µg/g	2 / 2	2 / 2	100%	--	--	460	460	--	--	Undetermined	--	460	#	1,206	[bk]
Vanadium	µg/g	2 / 2	2 / 2	100%	--	--	19	24	--	--	Undetermined	--	24	#	92	[bk]
Toluene	µg/g	1 / 2	1 / 2	50%	0.0025	0.0025	0.0019	0.0019	--	--	Undetermined	--	0.0019	#	--	[CEB]
Total Organic Carbon	µg/g	1 / 2	1 / 2	50%	1000	1000	1,350	1,350	--	--	Undetermined	--	1,350	#	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)


N 1,032,100
E 511,150
22
SS-22-002
SB-22-048
SS-22-006
SS-22-005
SS-22-003
SB-22-047
SS-22-001
SB-22-049
SS-22-004
STATE PLANE GRID
0 50 100 200
SCALE: 1" = 100'
NOTE:
1 Contaminant group not analyzed at this depth.
2 Lead analysis only.
N 1,031,400
E 511,725
LEGEND:
PRIMARY ROAD
AREA BOUNDARY
STUDY AREA
SURFACE SOIL CONFIRMATION SAMPLE
SOIL BORING CONFIRMATION SAMPLE
ALABAMA STATE PLANE GRID (EAST)
SAMPLE DEPTH
0 - <1 FEET
1 - 10 FEET
>10 FEET
ANALYTICAL GROUPS
SVOCs
METALS
VOCs
EXPLOSIVES
U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA
CEBs in Soil at
Study Area 22
Figure No. 4-33
Project No. 03-8178-045
File Name 99015\DWGS\E42PIE21
Date 03-31-99

reported throughout Area B during the Supplemental RI. Concentrations of barium (1,100 µg/g), cadmium (18 µg/g), chromium (259 µg/g), copper (2,800 µg/g), iron (110,000 µg/g), lead (15,000 µg/g) nickel (259 µg/g), and zinc (5,500 µg/g) detected in shallow subsurface soil samples from SB-22-048 were the highest reported throughout Area B during the Supplemental RI at that depth.

Lead concentrations in Study Area 22 soils varied widely from nondetect in several deep subsurface soils to 15,000 µg/g at SB-22-048 (5 feet BLS). Lead concentrations at SB-22-047 decreased with increasing depth, while samples from locations SB-22-048 and SB-22-049 showed no clear distribution pattern with depth. The highest lead concentrations at SB-22-048 and SB-22-049 were at 5 and 20 feet BLS, respectively.

Explosives—Two explosives were detected in one shallow subsurface soil sample (SB-22-048) collected at Study Area 22 and are listed in the adjacent box. The sample, collected from a depth of 1 foot BLS, is located in the center of Study Area 22. Explosives were not detected in the sample collected at 5 feet BLS in the same boring.

Maximum Concentrations			
Analyte (µg/g)	0-<1ft	1-10ft	>10ft
TNT		0.209	
2,4-Dinitrotoluene		0.125	

VOCs—Three VOCs were detected at concentrations near the CRL in soil samples collected at Study Area 22. The VOCs and their maximum concentrations reported in each soil interval are listed in the adjacent box.

Maximum Concentrations			
Analyte (µg/g)	0-<1ft	1-10ft	>10ft
Acetone	0.026		
Methylene Chloride	0.0048	0.0069	
Toluene	0.0049	0.052	0.0019

Results of acetone analyses for samples collected before June 19, 1995 (as was the surface sample collected at SS-22-002) are believed to be suspect as a result of field laboratory activities (see Section 4.2 for additional information).

Concentrations of methylene chloride and toluene detected in Study Area 22 soils were near or below the CRL, with the exception of the 1-foot BLS sample at SB-22-047, which had a toluene concentration of 0.052 µg/g. Toluene was not detected in the deeper samples collected at this location. These concentrations are not indicative of significant VOC contamination in the surface and subsurface soils.

SVOCs—Seventeen SVOCs (16 of which are PAHs) were detected in shallow subsurface soil collected from sampling location SB-22-048

Maximum Concentrations			
Analyte (µg/g)	0-<1ft	1-10ft	>10ft
2-Methylnaphthalene		30	
Acenaphthene		100	
Anthracene		200	
Benzo(a)anthracene		90	
Benzo(a)pyrene		100	
Benzo(b)fluoranthene		50,000	
Benzo(g,h,i)perylene		5,000	
Benzo(k)fluoranthene		700	
Chrysene		400	
Dibenzo(a,h)anthracene		300	
Dibenzofuran		80	
Fluoranthene		300	
Fluorene		100	
Indeno(1,2,3-cd)pyrene		1,000	
Naphthalene		80	
Phenanthrene		1,000	
Pyrene		1,000	

and are listed in the adjacent box. Of the 17 SVOCs, 16 were detected only in the sample collected at a depth of 1 foot BLS at SB-22-048, located in the center of Study Area 22.

The concentrations of the PAHs detected in SB-22-048 from 1 foot BLS were the highest concentrations reported in shallow subsurface soils during the Supplemental RI. Benzo(a)anthracene was the only PAH detected at depths greater than 1 foot BLS in SB-22-048. Benzo(a)anthracene was detected at concentrations <0.2 µg/g in shallow subsurface soil samples collected from SB-22-048 at depths of 5 feet BLS (0.13 µg/g), 1 foot BLS (90 µg/g), and 10 feet BLS (0.17 µg/g). Deep subsurface samples were not collected at location SB-22-048.

Summary—Several chemicals are present in the soils at the Demolition Landfill, including explosives, VOCs, SVOCs, and metals above background concentrations. The most notable result was the detection of 17 SVOCs in the shallow subsurface soils (less than 10 feet) at concentrations up to 50,000 µg/g. The SVOCs detected at Study Area 22 seem to be limited to the shallow subsurface soils. The 17 detected SVOCs (16 of which were PAHs) were limited to a single boring location at the central portion of the study area (SB-22-048). Sixteen of the 17 SVOCs were identified only in the shallowest subsurface soil interval (1 foot BLS). Only one PAH, benzo(a)anthracene, was identified in the 5- and 10-foot interval of that boring. This lack of vertical migration is expected because of the chemical nature of the detected compounds.

Metals contamination was identified at Study Area 22 in all sampling intervals. Concentrations of eight metals in selected sampling intervals were the highest reported throughout Area B during the Supplemental RI. Explosives contamination of the soils is limited; TNT and 2,4-DNT were detected in the shallow subsurface soils at concentrations less than 0.21 µg/g. Similarly, low concentrations (near the CRL) of VOCs were detected in the subsurface soils at the Demolition Landfill. The horizontal extent of soil contamination is not clearly defined, but the results indicate that it is located primarily in the central portion of the landfill.

4.5.16 Study Area 25 – Storage Battery/Demolition Debris

The only reference to the use of this study area was in the Installation Assessment Report, which noted a small area, east of water intake plant No. 3, that was used as a dumping ground for old construction debris (DA 1978). During a site visit in 1985 (ESE 1986), rubble and at least 20 heavy-duty lead-acid battery casings were found. These casings consisted of approximately 30 pounds of lead components in a glass casing. In addition, three mercury switches, each containing 3 to 4 mm of liquefied mercury metal, were observed. During the previously conducted RI (ESE 1986) arsenic, chromium, copper, lead, nickel, thallium, zinc, and TNT were detected in the soil.

During Phase 1 of the Supplemental RI, surface soil samples from three locations and subsurface soil samples from three borings were collected and screened for lead on a quick-turnaround basis at the offsite laboratory. Three surface soil samples and eight subsurface soil samples from three borings were collected and analyzed in the laboratory for metals, explosives,

VOCs, and SVOCs. In addition, two of the surface and two of the subsurface soil samples were collected and analyzed for hexavalent chromium.

The data summary tables for Study Area 25 are presented in Appendix K. **Tables 4-59** through **4-61** present summary statistics for the soils at Study Area 25. **Figure 4-34** shows the locations where the general contaminant group CEBs (metals, SVOCs, VOCs, and explosives) were detected in Study Area 25 soils. Sheets 4-5 and 4-6 present the screening results for surface and subsurface soils, respectively, for Study Area 25.

Metals—Eighteen metals were detected at concentrations exceeding background in surface soils. The metals are listed in the adjacent box. Twelve metals were detected at concentrations exceeding background in the surface soils. The maximum concentrations of eight of the metals (beryllium, chromium, copper, iron, lead, mercury, vanadium, and zinc) in the surface soils were detected in sample SS-25-002. Maximum surface soil concentrations of aluminum, arsenic, nickel, and potassium were detected in sample SS-25-003. None of the maximum concentrations of metals that exceeded background was identified at the SS-25-001 sample location.

Maximum Concentrations*			
Analyte (µg/g)	0-<1ft**	1-10ft	>10ft**
Aluminum	27,000		28,000
Arsenic	20.1		
Barium		82.2	72.7
Beryllium	0.846	2.11	4.8
Calcium			1,220
Chromium	55.7		
Cobalt		34.5	
Copper	22.2	27	64.8
Iron	46,000		58,000
Lead	51.8	48.3	32.2
Magnesium		1,780	1,980
Manganese		1,000	1,500
Mercury	0.118		
Nickel	19.8	28.8	
Potassium	1,410	2,140	2,550
Sodium		**57.4**	
Vanadium	77.6		
Zinc	262		

* Metals also determined to exceed background based on ANOVA evaluation are shown in bold.

** ANOVA evaluation not conducted because there are fewer than four samples in the data set.

Ten metals were detected at concentrations exceeding background in the shallow subsurface soils collected from depths between 1 and 10 feet BLS. The maximum metal concentrations detected in the shallow subsurface interval were detected in the samples collected from 10 feet BLS, except for sodium, which was detected at a maximum concentration in the 5-foot BLS sample.

Ten metals were detected at concentrations greater than background in the deep subsurface soils. The maximum concentrations of aluminum, barium, lead, magnesium, manganese, and potassium in deep subsurface soils were detected in the 20-foot BLS sample at SB-25-051. Beryllium, calcium, copper, and iron concentrations in deep subsurface soils were detected at maximum concentrations in the 15-foot BLS sample at SB-25-052.

Explosives—Explosives were not detected in any of the soil samples collected at Study Area 25.

Table 4-59. Summary Statistics and Exposure Point Concentrations for Soil (0-<1 ft BLS) at Study Area 25 - Storage Battery/Demolition Debris
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:18:26 PM
Run Date: 3/29/99
Exposure Unit: 25__SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	3 / 3	3 / 3	100%	--	--	15,000	27,000	--	--	Undetermined	--	27,000	#	20,277	[CEB]
Arsenic	µg/g	2 / 3	2 / 3	67%	13	13	18	20	--	--	Undetermined	--	20	#	15	[CEB]
Barium	µg/g	3 / 3	3 / 3	100%	--	--	73	118	--	--	Undetermined	--	118	#	124	[bk]
Beryllium	µg/g	3 / 3	3 / 3	100%	--	--	0.69	0.85	--	--	Undetermined	--	0.85	#	0.82	[CEB]
Calcium	µg/g	3 / 3	3 / 3	100%	--	--	862	2,450	--	--	Undetermined	--	2,450	#	4,960	[bk]
Chromium	µg/g	3 / 3	3 / 3	100%	--	--	35	56	--	--	Undetermined	--	56	#	54	[CEB]
Cobalt	µg/g	1 / 3	1 / 3	33%	2.5	2.5	3.3	3.3	--	--	Undetermined	--	3.3	#	14	[bk]
Copper	µg/g	3 / 3	3 / 3	100%	--	--	9.7	22	--	--	Undetermined	--	22	#	13	[CEB]
Iron	µg/g	3 / 3	3 / 3	100%	--	--	17,000	46,000	--	--	Undetermined	--	46,000	#	37,560	[CEB]
Lead	µg/g	3 / 3	3 / 3	100%	--	--	25	52	--	--	Undetermined	--	52	#	34	[CEB]
Magnesium	µg/g	3 / 3	3 / 3	100%	--	--	825	881	--	--	Undetermined	--	881	#	1,189	[bk]
Manganese	µg/g	3 / 3	3 / 3	100%	--	--	330	650	--	--	Undetermined	--	650	#	1,730	[bk]
Mercury	µg/g	1 / 3	1 / 3	33%	0.087	0.087	0.12	0.12	--	--	Undetermined	--	0.12	#	0.056	[CEB]
Nickel	µg/g	3 / 3	3 / 3	100%	--	--	10	20	--	--	Undetermined	--	20	#	9.4	[CEB]
Potassium	µg/g	3 / 3	3 / 3	100%	--	--	767	1,410	--	--	Undetermined	--	1,410	#	680	[CEB]
Sodium	µg/g	1 / 3	1 / 3	33%	50	50	66	66	--	--	Undetermined	--	66	#	501	[bk]
Vanadium	µg/g	3 / 3	3 / 3	100%	--	--	33	78	--	--	Undetermined	--	78	#	76	[CEB]
Zinc	µg/g	3 / 3	3 / 3	100%	--	--	64	262	--	--	Undetermined	--	262	#	36	[CEB]
Acetone	µg/g	1 / 3	1 / 3	33%	0.045	0.045	0.027	0.027	--	--	Undetermined	--	0.027	#	--	[CEB]
Benzoic Acid	µg/g	1 / 3	1 / 3	33%	0.92	0.92	7.3	7.3	--	--	Undetermined	--	7.3	#	--	[CEB]
Toluene	µg/g	2 / 3	2 / 3	67%	0.0025	0.0025	0.0034	0.022	--	--	Undetermined	--	0.022	#	--	[CEB]
Total Organic Carbon	µg/g	3 / 3	3 / 3	100%	--	--	36,400	50,100	--	--	Undetermined	--	50,100	#	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: If the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-60. Summary Statistics and Exposure Point Concentrations for Soil (1-10 ft BLS) at Study Area 25 - Storage Battery/Demolition Debris
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:18:26 PM
Run Date: 3/29/99
Exposure Unit: 25_SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	6 / 6	6 / 6	100%	--	--	13,000	25,000	17,000	4,243	Normal	20,490	20,490		27,733	[bk]
Arsenic	µg/g	3 / 6	3 / 6	50%	13	13	17	34	16	12	Normal	27	27		42	[bk]
Barium	µg/g	6 / 6	6 / 6	100%	--	--	23	82	49	22	Normal	67	67		64	[CEB][ANOVA]
Beryllium	µg/g	5 / 6	5 / 6	83%	0.25	0.25	0.38	2.1	1.0	0.78	Normal	1.7	1.7		0.80	[CEB][ANOVA]
Calcium	µg/g	6 / 6	6 / 6	100%	--	--	255	1,150	596	340	Normal	876	876		2,475	[bk]
Chromium	µg/g	4 / 6	4 / 6	67%	16	30	21	46	25	14	Normal	37	37		46	[bk]
Cobalt	µg/g	4 / 6	4 / 6	67%	2.5	2.5	4.3	35	8.9	13	Lognormal	150	35	#	7.0	[CEB][ANOVA]
Copper	µg/g	6 / 6	6 / 6	100%	--	--	6.3	27	17	8.2	Normal	23	23		26	[CEB][ANOVA]
Iron	µg/g	6 / 6	6 / 6	100%	--	--	19,000	51,000	35,833	13,467	Normal	46,912	46,912		52,000	[bk]
Lead	µg/g	6 / 9	6 / 9	67%	10.0	10.0	13	48	19	16	Normal	28	28		14	[CEB][ANOVA]
Magnesium	µg/g	6 / 6	6 / 6	100%	--	--	495	1,780	873	483	Lognormal	1,549	1,549		1,399	[CEB][ANOVA]
Manganese	µg/g	6 / 6	6 / 6	100%	--	--	85	1000	456	396	Normal	783	783		682	[CEB][ANOVA]
Nickel	µg/g	4 / 6	4 / 6	67%	7.5	7.5	12	29	14	10	Normal	23	23		21	[CEB][ANOVA]
Potassium	µg/g	6 / 6	6 / 6	100%	--	--	267	2,140	787	683	Lognormal	2,167	2,140	#	1,324	[CEB][ANOVA]
Sodium	µg/g	1 / 6	1 / 6	17%	50	50	57	57	30	13	Lognormal	43	43		--	[CEB]
Vanadium	µg/g	6 / 6	6 / 6	100%	--	--	27	74	43	16	Lognormal	61	61		96	[bk]
Zinc	µg/g	6 / 6	6 / 6	100%	--	--	21	62	42	15	Normal	54	54		71	[bk]
Methylene Chloride	µg/g	3 / 6	3 / 6	50%	0.0062	0.0062	0.0044	0.0100	0.0050	0.0027	Lognormal	0.0087	0.0087		--	[CEB]
Toluene	µg/g	1 / 6	1 / 6	17%	0.0025	0.0025	0.0100	0.0100	0.0027	0.0036	Lognormal	0.010	0.0100	#	--	[CEB]
Total Organic Carbon	µg/g	5 / 6	5 / 6	83%	1000	1000	1,310	4,570	2,337	1,406	Normal	3,493	3,493		--	[CEB]

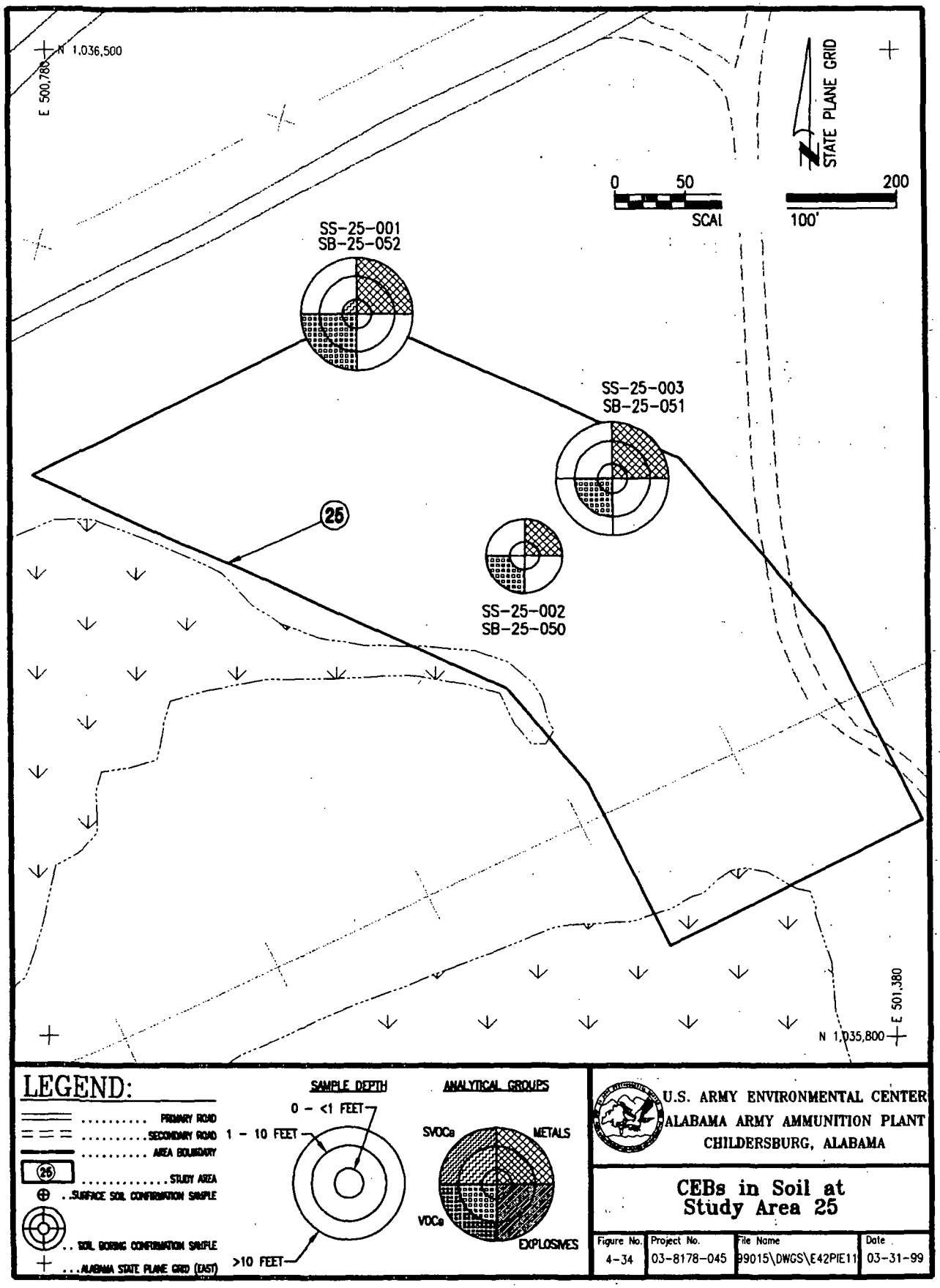
[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: If the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-61. Summary Statistics and Exposure Point Concentrations for Soil (>10 ft BLS) at Study Area 25 - Storage Battery/Demolition Debris
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:18:26 PM
Run Date: 3/29/99
Exposure Unit: 25_SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	2 / 2	2 / 2	100%	--	--	5,330	28,000	--	--	Undetermined	--	28,000	#	27,567	[CEB]
Arsenic	µg/g	1 / 2	1 / 2	50%	13	13	23	23	--	--	Undetermined	--	23	#	52	[bk]
Barium	µg/g	2 / 2	2 / 2	100%	--	--	18	73	--	--	Undetermined	--	73	#	41	[CEB]
Beryllium	µg/g	2 / 2	2 / 2	100%	--	--	3.3	4.8	--	--	Undetermined	--	4.8	#	0.89	[CEB]
Calcium	µg/g	2 / 2	2 / 2	100%	--	--	953	1,220	--	--	Undetermined	--	1,220	#	257	[CEB]
Chromium	µg/g	2 / 2	2 / 2	100%	--	--	15	30	--	--	Undetermined	--	30	#	53	[bk]
Cobalt	µg/g	2 / 2	2 / 2	100%	--	--	19	28	--	--	Undetermined	--	28	#	58	[bk]
Copper	µg/g	2 / 2	2 / 2	100%	--	--	46	65	--	--	Undetermined	--	65	#	56	[CEB]
Iron	µg/g	2 / 2	2 / 2	100%	--	--	32,000	58,000	--	--	Undetermined	--	58,000	#	57,000	[CEB]
Lead	µg/g	3 / 3	3 / 3	100%	--	--	15	32	--	--	Undetermined	--	32	#	32	[CEB]
Magnesium	µg/g	2 / 2	2 / 2	100%	--	--	797	1,980	--	--	Undetermined	--	1,980	#	867	[CEB]
Manganese	µg/g	2 / 2	2 / 2	100%	--	--	710	1,500	--	--	Undetermined	--	1,500	#	1,331	[CEB]
Mercury	µg/g	1 / 2	1 / 2	50%	0.087	0.087	0.22	0.22	--	--	Undetermined	--	0.22	#	0.36	[bk]
Nickel	µg/g	2 / 2	2 / 2	100%	--	--	31	43	--	--	Undetermined	--	43	#	46	[bk]
Potassium	µg/g	2 / 2	2 / 2	100%	--	--	402	2,550	--	--	Undetermined	--	2,550	#	1,206	[CEB]
Vanadium	µg/g	2 / 2	2 / 2	100%	--	--	35	45	--	--	Undetermined	--	45	#	92	[bk]
Zinc	µg/g	2 / 2	2 / 2	100%	--	--	58	67	--	--	Undetermined	--	67	#	104	[bk]
Methylene Chloride	µg/g	1 / 2	1 / 2	50%	0.0062	0.0062	0.0071	0.0071	--	--	Undetermined	--	0.0071	#	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)


N 1,036,500
E 500,780
STATE PLANE GRID
0
50
200
SCAL
100'
SS-25-001
SB-25-052
SS-25-003
SB-25-051
25
SS-25-002
SB-25-050
E 501,380
N 1,035,800
LEGEND:
PRIMARY ROAD
SECONDARY ROAD
AREA BOUNDARY
STUDY AREA
SURFACE SOIL CONFIRMATION SAMPLE
SOIL BORING CONFIRMATION SAMPLE
ALABAMA STATE PLANE GRID (EAST)
SAMPLE DEPTH
0 - <1 FEET
1 - 10 FEET
>10 FEET
ANALYTICAL GROUPS
SVOCs
METALS
VOCs
EXPLOSIVES
U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA
CEBs in Soil at
Study Area 25
Figure No.
4-34
Project No.
03-8178-045
File Name
99015\DWGS\E42PIE11
Date
03-31-99

VOCs—Three VOCs were detected at low (≤0.03 µg/g) concentrations and are listed in the adjacent box. Acetone was detected in only one sample (surface soil sample SS-25-001). Results of acetone analyses for samples collected before June 19, 1995 (as was SS-25-001), are believed to be suspect as a result of field laboratory activities (see Section 4.2 for additional details). Toluene was detected at concentrations less than 0.03 µg/g in two surface and one shallow subsurface soil sample.

Maximum Concentrations			
Analyte (µg/g)	0-<1ft	1-10ft	>10ft
Acetone	0.027		
Methylene Chloride		0.01	0.0071
Toluene	0.022	0.01	

SVOCs—Only one SVOC, benzoic acid, was detected at a concentration of 7.3 µg/g in the surface soil at location SS-25-001. No other SVOCs were detected in the surface or subsurface soils at Study Area 25.

Summary—Metals were detected at concentrations above background in soils at each of the three sampling locations selected at Study Area 25. Soil boring sample results indicate that metals concentrations in the subsurface soils increase with depth for many of the detected metals. Seven metals (aluminum, barium, beryllium, copper, iron, lead, and manganese) were identified at concentrations exceeding background in the deep subsurface soils at Study Area 25. Maximum concentrations for four of the deep subsurface soil metals were detected at 20 feet BLS at SB-25-051 and maximum concentrations of three of the deep subsurface soil metals were detected at 15 feet BLS at SB-25-052. However, detected metals concentrations generally were not high compared to concentrations at other study areas. The maximum concentration of lead detected in Study Area 25 soils was 51.8 µg/g. These results are consistent with the reported information on the use of the study area as a dumping ground for batteries, switches, and construction debris. VOCs were detected in samples from all three locations, but at concentrations near the CRL. One SVOC, benzoic acid, was detected in the surface soil. Explosives were not present.

4.5.17 Building 6 – Coke Oven

The Coke Oven is located in the northernmost portion of Study Area 2. It was identified as a low-lying area that received surface water drainage from the majority of Study Area 2. Little information is available regarding the types of activities that occurred at the Coke Oven itself.

Ten soil sampling locations were established at the Coke Oven during the Supplemental RI. Surface soil samples were collected at all 10 locations for explosives screening and confirmatory analyses. Two soil borings were drilled; subsurface soil samples were collected and screened for explosives. One shallow subsurface and two deep subsurface soil samples were collected from each boring. All soil samples were analyzed for metals, VOCs, SVOCs, and explosives.

Appendix K presents data summary tables for the Coke Oven. **Tables 4-62** through **4-64** present summary statistics for Coke Oven soils. **Figure 4-35** shows the locations where the general

Table 4-62. Summary Statistics and Exposure Point Concentrations for Soil (0-<1 ft BLS) at Study Area B6 - Building 6 - Coke Oven
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:39:21 PM
Run Date: 3/29/99
Exposure Unit: B6__SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]	2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	10 / 10	10 / 10	100%	--	--	19,000	34,000	25,600	4,600	Normal	28,266	28,266	20,277	[CEB]
Arsenic	µg/g	6 / 10	6 / 10	60%	13	13	18	29	16	8.8	Normal	21	21	15	[CEB][ANOVA]
Barium	µg/g	10 / 10	10 / 10	100%	--	--	89	211	165	48	Lognormal	210	210	124	[CEB]
Beryllium	µg/g	10 / 10	10 / 10	100%	--	--	1.00	2.7	1.8	0.55	Normal	2.2	2.2	0.82	[CEB]
Calcium	µg/g	10 / 10	10 / 10	100%	--	--	3,000	47,000	22,634	15,708	Normal	31,739	31,739	4,960	[CEB]
Cobalt	µg/g	1 / 10	1 / 10	10%	2.5	2.5	4.0	4.0	1.5	0.86	Lognormal	1.9	1.9	14	[bk]
Copper	µg/g	10 / 10	10 / 10	100%	--	--	12	57	29	11	Lognormal	39	39	13	[CEB]
Iron	µg/g	10 / 10	10 / 10	100%	--	--	27,000	54,000	36,800	8,561	Normal	41,763	41,763	37,560	[CEB]
Lead	µg/g	10 / 10	10 / 10	100%	--	--	20	84	54	19	Normal	65	65	34	[CEB]
Magnesium	µg/g	10 / 10	10 / 10	100%	--	--	1,010	8,500	3,557	2,521	Normal	5,018	5,018	1,189	[CEB]
Manganese	µg/g	10 / 10	10 / 10	100%	--	--	430	730	593	120	Normal	663	663	1,730	[bk]
Mercury	µg/g	1 / 10	1 / 10	10%	0.087	0.087	0.11	0.11	0.050	0.021	Lognormal	0.061	0.061	0.056	[CEB]
Nickel	µg/g	9 / 10	9 / 10	90%	7.5	7.5	9.6	23	14	5.2	Normal	17	17	9.4	[CEB]
Potassium	µg/g	10 / 10	10 / 10	100%	--	--	1,120	3,320	2,021	616	Normal	2,378	2,378	680	[CEB]
Sodium	µg/g	10 / 10	10 / 10	100%	--	--	78	343	194	89	Normal	245	245	501	[bk]
Vanadium	µg/g	10 / 10	10 / 10	100%	--	--	39	73	54	9.9	Normal	60	60	76	[bk]
Zinc	µg/g	10 / 10	10 / 10	100%	--	--	60	132	94	21	Normal	106	106	36	[CEB]
Benzo(a)anthracene	µg/g	1 / 10	1 / 10	10%	0.17	0.17	0.13	0.13	0.090	0.014	Lognormal	0.097	0.097	--	[CEB]
Cyclotetramethylenetetranitramine	µg/g	1 / 10	1 / 10	10%	0.16	0.16	0.52	0.52	0.12	0.14	Lognormal	0.18	0.18	--	[CEB]
Methylene Chloride	µg/g	2 / 11	2 / 11	18%	0.0062	0.0062	0.0068	0.0068	0.0038	0.0015	Lognormal	0.0046	0.0046	--	[CEB]
Phenanthrene	µg/g	2 / 10	2 / 10	20%	0.17	0.17	0.19	0.22	0.11	0.051	Lognormal	0.14	0.14	--	[CEB]
Toluene	µg/g	5 / 11	5 / 11	45%	0.0025	0.0025	0.0032	0.053	0.0079	0.015	Lognormal	0.027	0.027	--	[CEB]
Total Organic Carbon	µg/g	10 / 10	10 / 10	100%	--	--	17,300	88,400	52,910	20,829	Normal	64,984	64,984	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: If the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-63. Summary Statistics and Exposure Point Concentrations for Soil (1-10 ft BLS) at Study Area B6 - Building 6 - Coke Oven
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:39:21 PM
Run Date: 3/29/99
Exposure Unit: B6_SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	2 / 2	2 / 2	100%	--	--	25,000	31,000	--	--	Undetermined	--	31,000	#	27,733	[CEB]
Arsenic	µg/g	2 / 2	2 / 2	100%	--	--	22	46	--	--	Undetermined	--	46	#	42	[CEB]
Barium	µg/g	2 / 2	2 / 2	100%	--	--	49	59	--	--	Undetermined	--	59	#	64	[bk]
Beryllium	µg/g	2 / 2	2 / 2	100%	--	--	0.81	0.94	--	--	Undetermined	--	0.94	#	0.80	[CEB]
Calcium	µg/g	2 / 2	2 / 2	100%	--	--	1,270	2,240	--	--	Undetermined	--	2,240	#	2,475	[bk]
Copper	µg/g	2 / 2	2 / 2	100%	--	--	21	24	--	--	Undetermined	--	24	#	26	[bk]
Iron	µg/g	2 / 2	2 / 2	100%	--	--	55,000	57,000	--	--	Undetermined	--	57,000	#	52,000	[CEB]
Lead	µg/g	2 / 2	2 / 2	100%	--	--	122	188	--	--	Undetermined	--	188	#	14	[CEB]
Magnesium	µg/g	2 / 2	2 / 2	100%	--	--	569	840	--	--	Undetermined	--	840	#	1,399	[bk]
Manganese	µg/g	2 / 2	2 / 2	100%	--	--	380	710	--	--	Undetermined	--	710	#	682	[CEB]
Mercury	µg/g	2 / 2	2 / 2	100%	--	--	0.16	0.19	--	--	Undetermined	--	0.19	#	0.12	[CEB]
Molybdenum	µg/g	1 / 2	1 / 2	50%	4.0	4.0	7.0	7.0	--	--	Undetermined	--	7.0	#	--	[CEB]
Nickel	µg/g	2 / 2	2 / 2	100%	--	--	15	17	--	--	Undetermined	--	17	#	21	[bk]
Potassium	µg/g	2 / 2	2 / 2	100%	--	--	535	1,080	--	--	Undetermined	--	1,080	#	1,324	[bk]
Sodium	µg/g	2 / 2	2 / 2	100%	--	--	71	88	--	--	Undetermined	--	88	#	--	[CEB]
Vanadium	µg/g	2 / 2	2 / 2	100%	--	--	82	88	--	--	Undetermined	--	88	#	96	[bk]
Zinc	µg/g	2 / 2	2 / 2	100%	--	--	178	226	--	--	Undetermined	--	226	#	71	[CEB]
Acetone	µg/g	1 / 2	1 / 2	50%	0.029	0.029	0.51	0.51	--	--	Undetermined	--	0.51	#	--	[CEB]
Methylene Chloride	µg/g	2 / 2	2 / 2	100%	--	--	0.0043	0.0046	--	--	Undetermined	--	0.0046	#	--	[CEB]
Toluene	µg/g	1 / 2	1 / 2	50%	0.0025	0.0025	0.0023	0.0023	--	--	Undetermined	--	0.0023	#	--	[CEB]
Total Organic Carbon	µg/g	2 / 2	2 / 2	100%	--	--	5,390	9,000	--	--	Undetermined	--	9,000	#	--	[CEB]

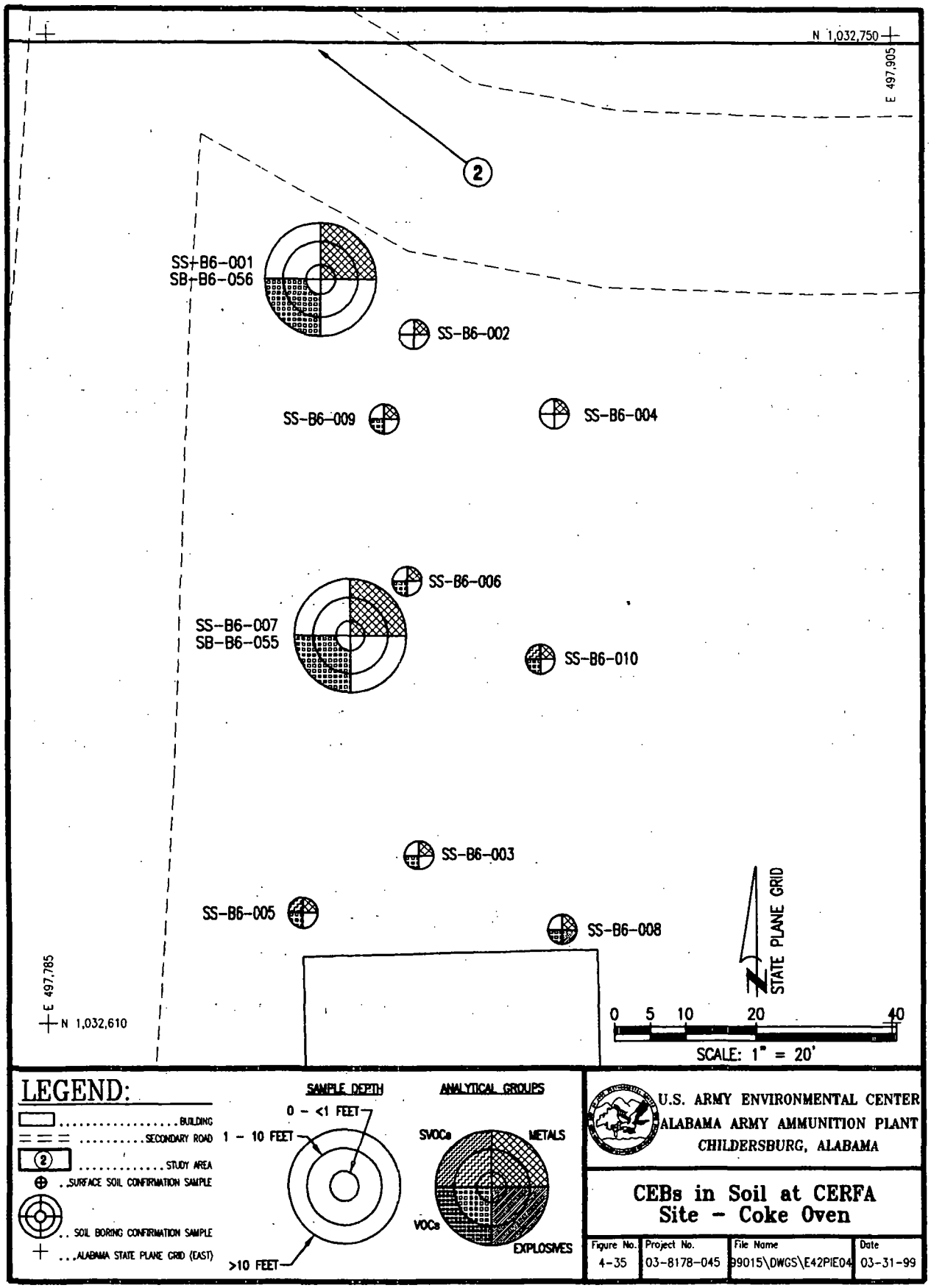
[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-64. Summary Statistics and Exposure Point Concentrations for Soil (>10 ft BLS) at Study Area B6 - Building 6 - Coke Oven
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:39:21 PM
Run Date: 3/29/99
Exposure Unit: B6__SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	3 / 3	3 / 3	100%	--	--	7,900	31,000	--	--	Undetermined	--	31,000	#	27,567	[CEB]
Arsenic	µg/g	3 / 3	3 / 3	100%	--	--	35	55	--	--	Undetermined	--	55	#	52	[CEB]
Barium	µg/g	3 / 3	3 / 3	100%	--	--	29	105	--	--	Undetermined	--	105	#	41	[CEB]
Beryllium	µg/g	3 / 3	3 / 3	100%	--	--	0.57	3.4	--	--	Undetermined	--	3.4	#	0.89	[CEB]
Calcium	µg/g	3 / 3	3 / 3	100%	--	--	733	1,680	--	--	Undetermined	--	1,680	#	257	[CEB]
Cobalt	µg/g	2 / 3	2 / 3	67%	2.5	2.5	11	148	--	--	Undetermined	--	148	#	58	[CEB]
Copper	µg/g	3 / 3	3 / 3	100%	--	--	15	26	--	--	Undetermined	--	26	#	56	[bk]
Iron	µg/g	3 / 3	3 / 3	100%	--	--	52,000	67,000	--	--	Undetermined	--	67,000	#	57,000	[CEB]
Lead	µg/g	3 / 3	3 / 3	100%	--	--	67	703	--	--	Undetermined	--	703	#	32	[CEB]
Magnesium	µg/g	3 / 3	3 / 3	100%	--	--	319	1,020	--	--	Undetermined	--	1,020	#	867	[CEB]
Manganese	µg/g	3 / 3	3 / 3	100%	--	--	191	3,000	--	--	Undetermined	--	3,000	#	1,331	[CEB]
Mercury	µg/g	3 / 3	3 / 3	100%	--	--	0.11	0.30	--	--	Undetermined	--	0.30	#	0.36	[bk]
Molybdenum	µg/g	1 / 3	1 / 3	33%	4.0	4.0	6.4	6.4	--	--	Undetermined	--	6.4	#	--	[CEB]
Nickel	µg/g	3 / 3	3 / 3	100%	--	--	32	120	--	--	Undetermined	--	120	#	46	[CEB]
Potassium	µg/g	2 / 3	2 / 3	67%	142	142	450	524	--	--	Undetermined	--	524	#	1,206	[bk]
Vanadium	µg/g	3 / 3	3 / 3	100%	--	--	52	89	--	--	Undetermined	--	89	#	92	[bk]
Zinc	µg/g	3 / 3	3 / 3	100%	--	--	97	412	--	--	Undetermined	--	412	#	104	[CEB]
Acetone	µg/g	2 / 3	2 / 3	67%	0.039	0.039	1.2	2.2	--	--	Undetermined	--	2.2	#	--	[CEB]
Methylene Chloride	µg/g	1 / 3	1 / 3	33%	0.0062	0.0062	0.0047	0.0047	--	--	Undetermined	--	0.0047	#	--	[CEB]
Toluene	µg/g	1 / 3	1 / 3	33%	0.0025	0.0025	0.0036	0.0036	--	--	Undetermined	--	0.0036	#	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: If the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)


N 1,032,750
E 497,905
2
SS-B6-001
SB-B6-056
SS-B6-002
SS-B6-009
SS-B6-004
SS-B6-006
SS-B6-007
SB-B6-055
SS-B6-010
SS-B6-003
SS-B6-005
SS-B6-008
E 497,785
N 1,032,610
STATE PLANE GRID
0 5 10 20 40
SCALE: 1" = 20'
LEGEND:
BUILDING
SECONDARY ROAD
STUDY AREA
SURFACE SOIL CONFIRMATION SAMPLE
SOIL BORING CONFIRMATION SAMPLE
ALABAMA STATE PLANE GRID (EAST)
SAMPLE DEPTH
0 - <1 FEET
1 - 10 FEET
>10 FEET
ANALYTICAL GROUPS
SVOCs
METALS
VOCs
EXPLOSIVES
U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA
CEBs in Soil at CERFA Site - Coke Oven
Figure No. 4-35
Project No. 03-8178-045
File Name 99015\DWGS\E42PIE04
Date 03-31-99

contaminant group CEBs (metals, SVOCs, VOCs, and explosives) were detected in Coke Oven soils. **Figure 4-36** presents screening results for surface and subsurface soils at the Coke Oven.

Metals—Thirteen metals were detected at concentrations exceeding background in surface soil samples collected from the vicinity of the Coke Oven. The metals and their maximum concentrations are listed in the adjacent box.

Maximum Concentrations*			
Analyte (µg/g)	0-<1ft	1-10ft**	>10ft**
Aluminum	**34,000**	31,000	31,000
Arsenic	28.8	46	55
Barium	**211**		105
Beryllium	**2.7**	0.942	3.39
Calcium	**47,000**		1,680
Cobalt			148
Copper	**57**		
Iron	**54,000**	57,000	67,000
Lead	**84.4**	188	703
Magnesium	8,500		1,020
Manganese		710	3,000
Mercury	**0.111**	0.185	
Molybdenum		6.96	6.44
Nickel	**22.6**		120
Potassium	**3,320**		
Sodium		87.6	
Zinc	**132**	226	412

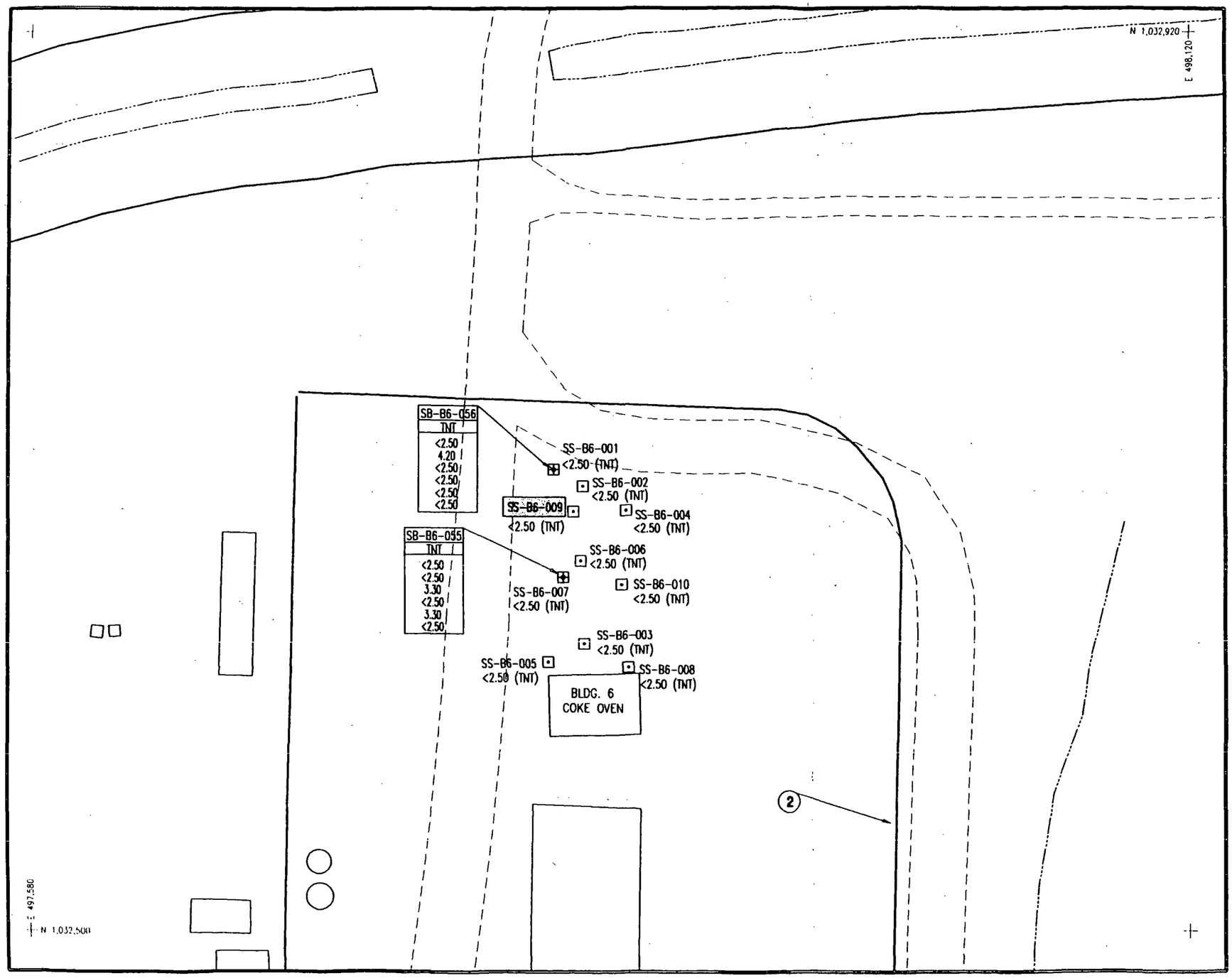
* Metals also determined to exceed background based on ANOVA evaluation are shown in bold.

** ANOVA evaluation was not conducted because there are fewer than four samples in the data set.

The distribution of metals in surface soils at the Coke Oven was irregular, and the maximum concentrations for specific metals were detected at many different sample locations. For example, the highest concentrations of aluminum, arsenic, iron, and zinc were detected in surface soil sample SS-B6-002, located at the northern end of the study area. In contrast, the lowest concentrations of both beryllium and barium were detected in SS-B6-002. The highest concentrations of beryllium were reported in SS-B6-003 (2.7 µg/g) and adjacent sample SS-B6-008 (2.59 µg/g). The highest concentration of barium was reported in sample SS-B6-004. A comparable concentration of barium (210 µg/g), as well as the highest concentrations of copper and nickel, were reported in samples from location SS-B6-007. The highest concentrations of lead and mercury were reported in the surface soil sample collected at SS-B6-005.

Ten metals (aluminum, arsenic, beryllium, iron, lead, manganese, mercury, molybdenum, sodium, and zinc) were detected at concentrations greater than background in the shallow subsurface soils. The maximum concentrations of aluminum, mercury, sodium, and zinc were detected in sample SB-B6-056 collected at 1 foot BLS. The maximum concentrations of arsenic, beryllium, iron, lead, manganese, and molybdenum were detected in sample SB-B6-055 at 1 foot BLS.

Thirteen metals (aluminum, arsenic, barium, beryllium, calcium, cobalt, iron, lead, magnesium, manganese, molybdenum, nickel, and zinc) were detected in the deep subsurface soils at concentrations that exceeded background. The maximum concentrations of aluminum, iron, nickel, and molybdenum were detected in sample SB-B6-056, at a depth of 15 feet BLS. The maximum concentrations of aluminum were the same in both the shallow and deep subsurface soils at soil boring location SB-B6-056. The maximum concentrations of barium, beryllium, calcium, cobalt, lead, magnesium, and manganese also were detected in sample SB-B6-056, but at a depth of 25 feet BLS. The maximum concentrations of arsenic and zinc were detected in sample SB-B6-055 at a depth of 25 feet BLS.



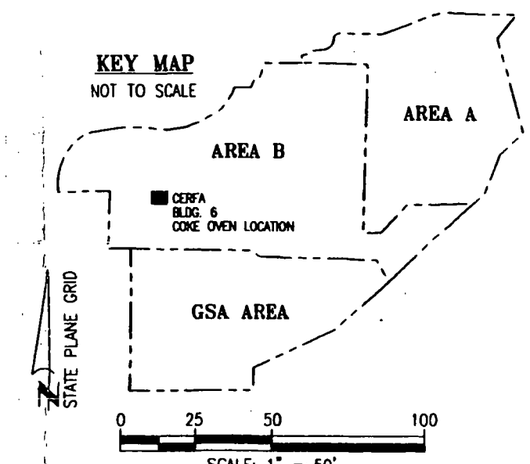
LEGEND:

- BUILDINGS
- PRIMARY ROADS
- SECONDARY ROADS
- TRIBUTARY OR STREAM
- (2) STUDY AREAS
- SS-B6-005 SURFACE SOIL LOCATION
- SB-B6-055 SOIL BORING LOCATION
- <2.50 CONCENTRATION (ug/g) OF EXPLOSIVES
- SB-B6-009 GEOTECHNICAL SAMPLE COLLECTED
- GRID BASED ON ALABAMA STATE PLANE EAST
- 1.0 - 3.0, 5.0 - 7.0, 10.0 - 12.0, 15.0 - 17.0, 20.0 - 22.0, 25.0 - 27.0 DEPTH INTERVAL (IN FEET) FOR SOIL BORINGS

NOTES:

1. BASE MAP OF AREA B RECEIVED FROM AIR SURVEY CORP. MAP COMPILED FROM AERIAL SURVEY FEBRUARY 1995.
2. OUTSIDE AREAS OF BASE MAP RECEIVED FROM AMERICAN DIGITAL CARTOGRAPHY, SCANNED FROM USGS CHILDERSBURG 7.5 QUADRANGLE, 1984, 1" = 100,000'.
3. ANALYTICAL RESULTS FOR EXPLOSIVES FROM SAIC VALIDATED DATA BASE SEPTEMBER, 1995.
4. ALL CONCENTRATIONS SHOWN ARE IN UNITS OF PARTS PER MILLION (ppm).

KEY MAP
NOT TO SCALE



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CHILDERSBURG, ALABAMA

CERFA - Field Screening Results - Surface Soils and Soil Borings (Explosives)

Figure No	Project No.	File Name	Date
4-36	01-0827-03-8178-045	99015\DWGS\E42CERFE	03-31-99

The concentrations of cobalt (148 µg/g), nickel (120 µg/g), and lead (703 µg/g) detected in deep subsurface soils collected from SB-B6-056 were the highest detected throughout Area B at that depth. The highest detected zinc concentration (412 µg/g) throughout Area B in deep subsurface soil was detected in SB-B6-055.

Explosives—Explosives were not detected in the surface soil samples collected for field screening. Explosives were present in the subsurface screening samples at concentrations less than 5 µg/g. One nontarget explosive compound, HMX, was detected in a surface soil sample (SS-B6-008) at a concentration of 0.518 µg/g. Because there is no known history of HMX production or use at ALAAP, the source of the HMX detected at the Coke Oven is unknown.

VOCs—Three VOCs were detected in soil samples collected from the vicinity of the Coke Oven. The VOCs and their maximum concentrations are listed in the adjacent box. Concentrations of methylene chloride detected in Coke Oven soils were near or below the detection limit of 0.006 µg/g. Acetone was detected at both soil boring locations. The concentrations of acetone in boring SB-B6-056 were greatest at 15 feet BLS (2.2 µg/g), but diminished considerably at 25 feet BLS (0.039 µg/g). Acetone was detected at a concentration of 1.2 µg/g at SB-B6-055 in the sample collected at 25 feet BLS, but was not detected at a depth of 1 foot BLS. Concentrations of toluene reported in samples collected at the Coke Oven were near or below the detection limits. Consequently, these concentrations are not indicative of significant VOC contamination in the surface and subsurface soils.

Maximum Concentrations			
Analyte (µg/g)	0-<1ft	1-10ft	>10ft
Acetone		0.51	2.2
Methylene Chloride	0.0068	0.0046	0.0047
Toluene	0.053	0.0023	0.0036

SVOCs—Two SVOCs were detected in surface soil samples collected in the vicinity of the Coke Oven. The SVOCs and their maximum concentrations are listed in the adjacent box. The two SVOCs were detected at concentrations less than or equal to 0.22 µg/g in only one surface soil sampling location (SS-B6-010). SVOCs were not detected in subsurface samples collected at the study area.

Maximum Concentrations			
Analyte (µg/g)	0-<1ft	1-10ft	>10ft
Benzo(a)anthracene	0.13		
Phenanthrene	0.22		

Summary—The most notable result of environmental sampling conducted at the Coke Oven was the occurrence of a large number of metals in surface soils (aluminum, arsenic, barium, beryllium, calcium, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, and zinc). This wide distribution tends to indicate that past site activities have released metals over much of the surface area associated with the site. The Coke Oven is located within Study Area 2 and each of these metals also was a CEB at that study area.

SVOCs were detected in Coke Oven soils at concentrations less than or equal to 0.22 µg/g. Acetone was detected in subsurface soils from both the Coke Oven (2.2 µg/g) and in Study Area 2

(1.1 μg/g). Other VOCs were detected at concentrations that are not indicative of significant VOC contamination. One nontarget explosive compound, HMX, was detected in the surface soil at the Coke Oven. There is no known source of HMX at ALAAP.

4.5.18 Downed Utility Poles with Transformers and Transformer Storage Buildings

According to the CERFA Report (TETC 1994), transformers were likely stored behind Building 2240 (an instrument shop) at one time. No evidence of stressed vegetation was noted during the site inspection. The CERFA Report also stated that a leaking transformer was stored in Building 2180, part of the Manhattan Project Area, and was removed in 1987. When demolition activities began in Area A (circa 1973–1974), the contractor stored transformers removed from Area A in Building 2180. When the transformers were removed, contractor cleanup activities consisted of throwing absorbent on any liquids present. In addition, old transformers that were stored behind Building 708A (a cafeteria) were vandalized.

Numerous former transformer sites within Area B were identified during the CERFA investigation. During the CERFA visual inspection, 27 utility poles were identified (TETC 1994). The soil under and around a broken transformer of a downed utility pole was blackened and bare of vegetation. The locations of the 27 utility poles were assigned numbers corresponding to the closest building:

- 708A–Three utility poles on north side
- 703E–Two utility poles on northwest portion
- 703A–Two utility poles on the southwest and one on the southeast portion
- 2240–Eight utility poles on south side
- 2170–One utility pole on the southeast and two on the south side
- 704Y–Three utility poles on the north side
- 717A–Two utility poles on the northeast and one on the southwest
- 715C–One utility pole on the southeast
- 227D–One utility pole on the north.

Surface and subsurface soils from each of the 27 utility pole areas and 2 transformer buildings were analyzed for PCBs, starting in visually stained areas and working out from those areas. PCB concentrations were estimated using the DTECH® field screening method (SW846 Method 4020). Ninety-five surface soil samples were collected and screened in the field for PCBs. Ten percent of the screened samples (a total of nine surface soil samples) were sent to the offsite laboratory for confirmation. Subsurface soils from each of the six sampled intervals from a soil boring (SB-PO-057) were analyzed for PCB contamination using the field test kits. The surface and bottom intervals were sent to the laboratory for confirmatory analysis.

The DTECH® PCB field screening kit yields results over a range (e.g., 1 to 4 parts per million [ppm]) of concentrations. A detection limit of 1 ppm was achieved with the test kit. Only

seven samples of the 95 total surface samples analyzed had values greater than the detection limit (1 ppm), and are presented in **Table 4-65**. The results of the PCB field sampling analyses and the locations of the sampling points are shown in **Figures 4-37** through **4-39**. All results were less than the screening criteria of 50 ppm. Subsurface soil results from the one soil boring were all less than the detection limit for the six intervals sampled to delineate vertical PCB contamination.

Based on the results of the PCB field screening, soil sampling locations were established in the vicinity of the utility poles and former transformer storage areas. Confirmatory samples collected for the utility poles were placed at the locations where the field screening results were positive for PCBs. Surface soil samples were collected from nine locations and were analyzed for PCBs. In addition, one soil boring, SB-PO-057, was drilled and sampled at a location south of Building 717A to aid in the delineation of potential PCB contamination. A shallow subsurface sample (1 foot BLS) and a deep subsurface sample (25 feet BLS) were collected from SB-PO-057 and analyzed for metals and PCBs.

Appendix K presents data summary tables for soils at the utility poles and former transformer storage buildings. **Tables 4-66** through **4-68** present summary statistics for soils. **Figures 4-40** through **4-42** show the locations where the general contaminant group CEBs (metals and PCBs) were detected in soils. An empty circle at 0 - <1 ft BLS indicates a sample was not collected in that interval.

Metals—Subsurface samples collected from the soil boring drilled at Building 715C (SB-PO-057) were analyzed for metals. Eleven metals were detected at concentrations exceeding background in the subsurface soil samples. The detected metals and their maximum concentrations are listed in the adjacent box. Of these 11 metals, the maximum concentrations of aluminum, chromium, copper, lead, and zinc in the shallow subsurface sample SB-PO-057 (1 foot BLS) exceeded background. The maximum concentrations of barium, beryllium, cadmium, calcium, magnesium, and manganese in the deep subsurface sample SB-PO-057 (25 feet BLS) were greater than background. No trend for the vertical distribution of metals could be determined from analytical results obtained from the soil boring.

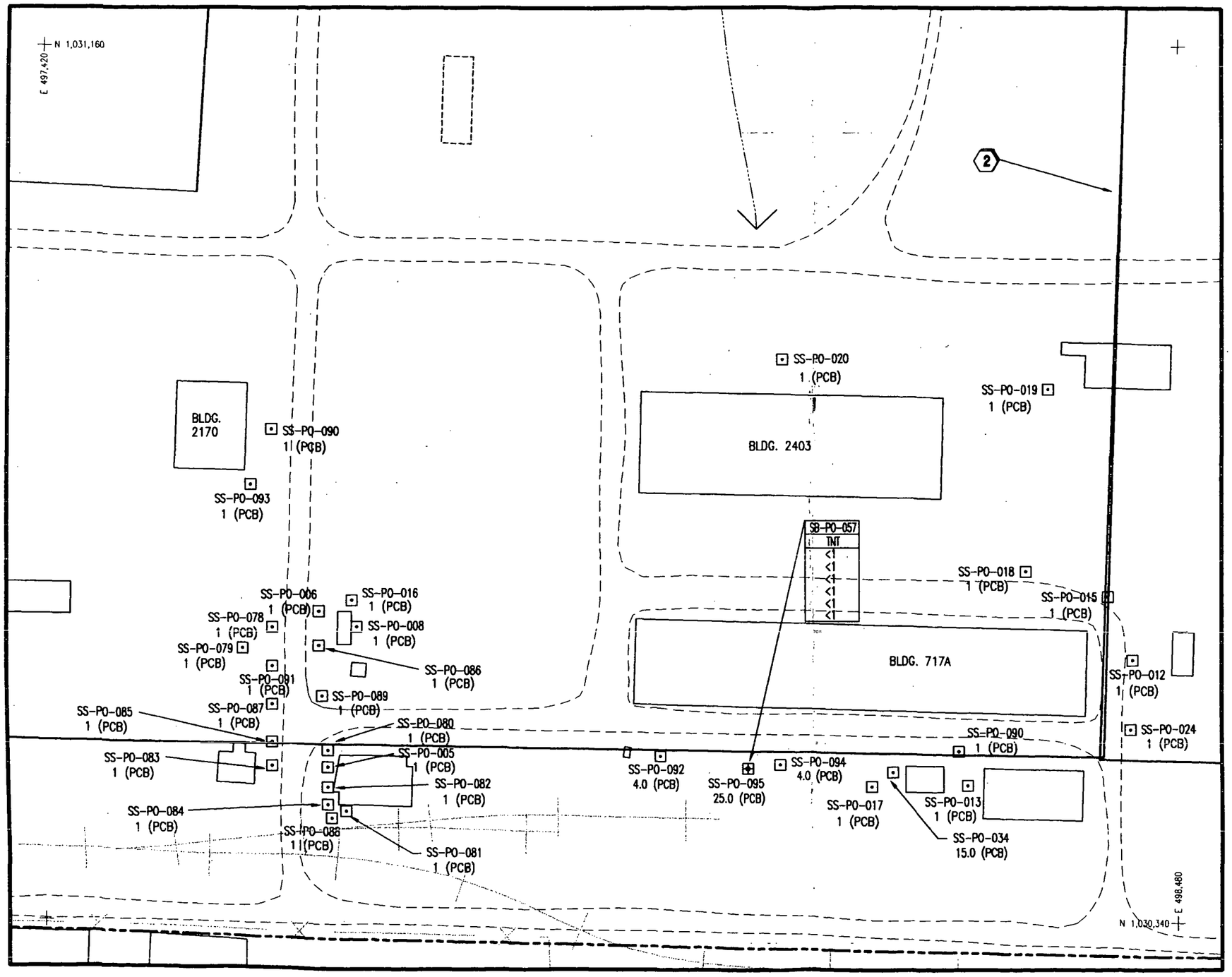
Maximum Concentrations*			
Analyte (µg/g)	0-<1ft	1-10ft**	>10ft**
Aluminum		28,000	
Barium			166
Beryllium			3.94
Cadmium			0.938
Calcium			**1,110**
Chromium		196	
Copper		37.9	
Lead		37.0	
Magnesium			**1,090**
Manganese			12,000
Zinc		126	

* Metals also determined to exceed background based on ANOVA evaluation are shown in bold.

** ANOVA evaluation was not conducted because there are fewer than four samples in the data set.

Table 4-65. Summary of Soil Screening Data - PCB - Surface Soil and Soil Boring
Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area	Number of Samples	Minimum Range	Maximum Range	Units	Number of Detects
PO Downed Utility Poles with Transformers	101	< 1	16 - 25	ppm	7



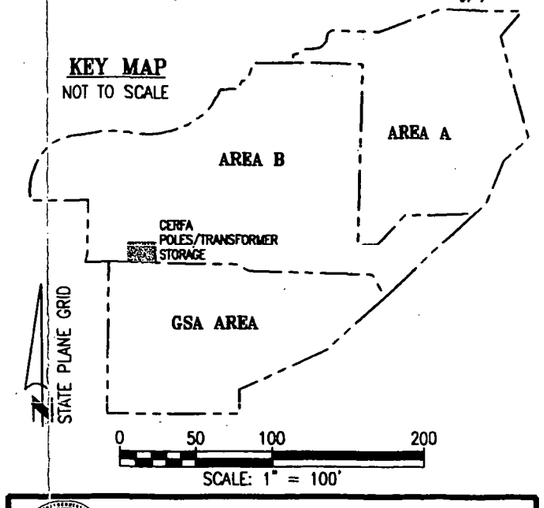
LEGEND:

- BUILDINGS
- PRIMARY ROADS
- SECONDARY ROADS
- AREA BOUNDARIES
- (2) STUDY AREAS
- FENCE
- SS-PO-095 SURFACE SOIL LOCATION
- SB-PO-057 SOIL BORING LOCATION
- 25.0 (PCB) ANALYTICAL RESULT FOR PCB's
- <2.50 ANALYTICAL RESULT FOR EXPLOSIVES
- GRID BASED ON ALABAMA STATE PLANE EAST
- 1.0 – 3.0, 5.0 – 7.0, 10.0 – 12.0, 15.0 – 17.0, 20.0 – 22.0, 25.0 – 27.0 DEPTH INTERVAL (IN FEET) FOR SOIL BORINGS

NOTES:

1. BASE MAP OF AREA B RECEIVED FROM AIR SURVEY CORP. MAP COMPILED FROM AERIAL SURVEY FEBRUARY 1995.
2. OUTSIDE AREAS OF BASE MAP RECEIVED FROM AMERICAN DIGITAL CARTOGRAPHY, SCANNED FROM USGS CHILDERSBURG 7.5 QUADRANGLE, 1984, 1" = 100,000'.
3. ANALYTICAL RESULTS FOR PCB' s RECEIVED FROM SAIC VALIDATED DATA BASE, AUGUST 1995.
4. ANALYTICAL RESULTS FOR EXPLOSIVES RECEIVED FROM SAIC VALIDATED DATA BASE, AUGUST 1995.
5. ALL CONCENTRATIONS SHOWN ARE IN UNITS OF PARTS PER MILLION (ppm).

KEY MAP
NOT TO SCALE



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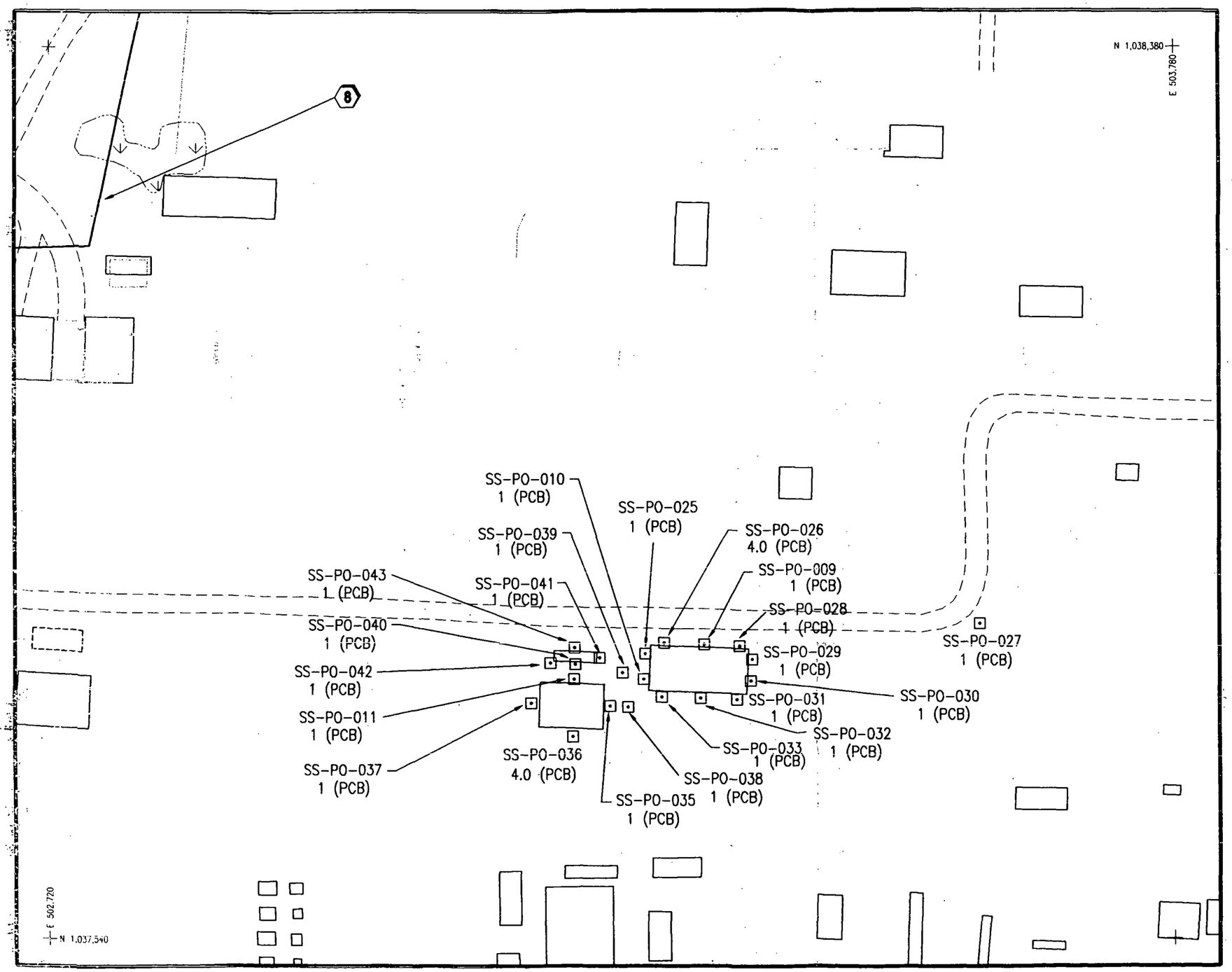
CHILDERSBURG, ALABAMA

CERFA – Field Screening Results
Surface Soils and Soil Borings (Explosives; PCB's)

Figure No.	Project No.	File Name	Date
4-37	01-0827-03-8178-045	99015\DWGS\E42CERFD	03-31-99

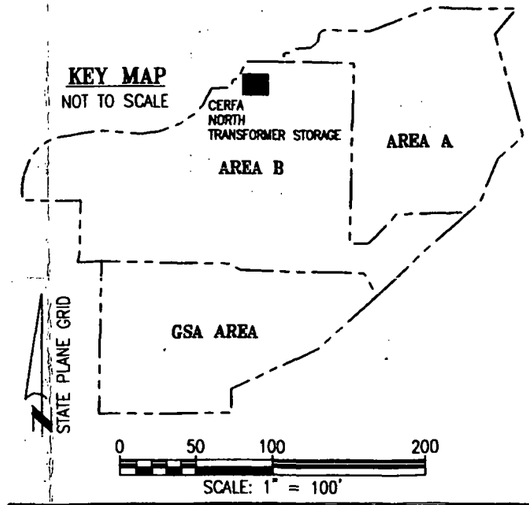


LEGEND:

- BUILDINGS
- PRIMARY ROADS
- SECONDARY ROADS
- AREA BOUNDARIES
- 8 ..... STUDY AREAS
- FENCE
- SS-PO-095 ..... SURFACE SOIL LOCATION
- 25.0 (PCB) ..... ANALYTICAL RESULT FOR PCB's
- GRID BASED ON ALABAMA STATE PLANE EAST

NOTES:

1. BASE MAP OF AREA B RECEIVED FROM AIR SURVEY CORP. MAP COMPILED FROM AERIAL SURVEY FEBRUARY 1995.
2. OUTSIDE AREAS OF BASE MAP RECEIVED FROM AMERICAN DIGITAL CARTOGRAPHY, SCANNED FROM USGS CHILDERSBURG 7.5 QUADRANGLE, 1984, 1" = 100,000'.
3. ANALYTICAL RESULTS FOR PCB' s RECEIVED FROM SAIC VALIDATED DATA BASE, AUGUST 1995.
4. ANALYTICAL RESULTS FOR EXPLOSIVES RECEIVED FROM SAIC VALIDATED DATA BASE, AUGUST 1995.
5. ALL CONCENTRATIONS SHOWN ARE IN UNITS OF PARTS PER MILLION (ppm).



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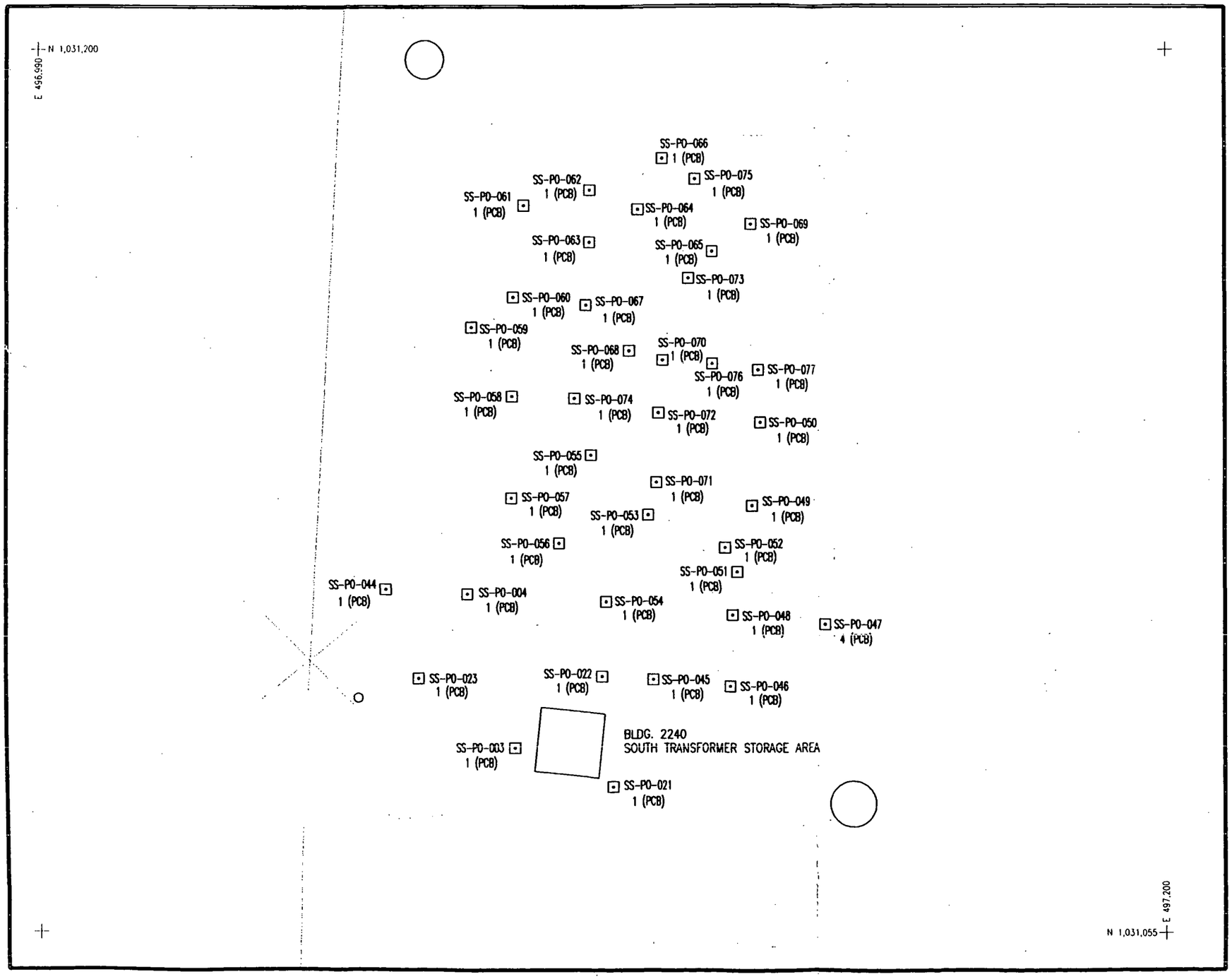
CHILDERSBURG, ALABAMA

CERFA – Field Screening Results
Surface Soils (PCB's)

Figure No.	Project No.	File Name	Date
4-38	01-0827-03-8178-045	99015\DWGS\E42CERFE	03-31-99

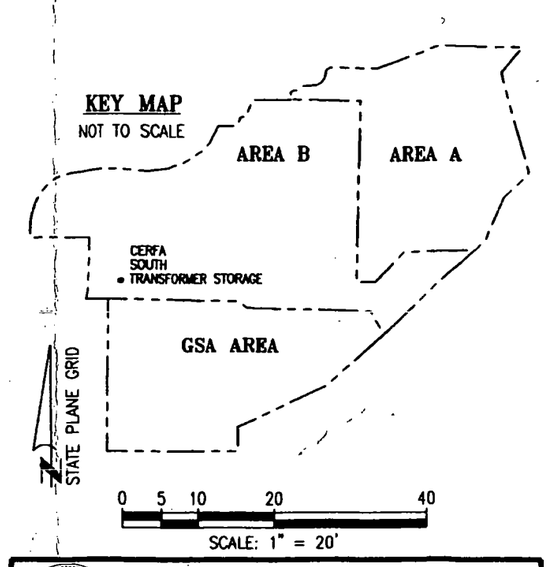


LEGEND:

- BUILDINGS
- PRIMARY ROADS
- FENCE
- SS-PO-047 ..... SURFACE SOIL LOCATION
- 4 (PCB) ..... ANALYTICAL RESULT FOR PCB's
- + ... GRID BASED ON ALABAMA STATE PLANE EAST

NOTES:

1. BASE MAP OF AREA B RECEIVED FROM AIR SURVEY CORP. MAP COMPILED FROM AERIAL SURVEY FEBRUARY 1995.
2. OUTSIDE AREAS OF BASE MAP RECEIVED FROM AMERICAN DIGITAL CARTOGRAPHY, SCANNED FROM USGS CHILDERSBURG 7.5 QUADRANGLE, 1984, 1" = 100,000'.
3. ANALYTICAL RESULTS FOR PCB's FROM SAIC VALIDATED DATA BASE SEPTEMBER, 1995.
4. ALL CONCENTRATIONS SHOWN ARE IN UNITS OF PARTS PER MILLION (ppm).



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CHILDERSBURG, ALABAMA

CERFA - Field Screening Results - Surface Soils (PCB's)

Figure No.	Project No.	File Name	Date
4-39	01-0827-03-8178-045	99015\DWGS\E42CERFC	03-31-99

Explosives—Explosives compounds were not detected in the background surface water samples.

VOCs—Acetone (30 μg/L), methylene chloride (2.6 μg/L), and toluene (1.1 μg/L) were variably detected in the background surface water samples. Acetone and methylene chloride each were detected in only one sample, while toluene was detected in two samples, both at concentrations of 1.1 μg/L.

SVOCs—SVOCs were not detected in the background surface water samples.

Summary—Surface water samples that were collected from five background locations (BK-BW-002, SW-BK-SAIC, SW-FC-025, SW-FC-026, and SW-FC-027) were obtained from streams that are located north and south of the facility with ultimate drainage to the Coosa River. Aluminum, antimony, arsenic, barium, iron, manganese, and selenium and the nutrient metals calcium, magnesium, potassium, and sodium were detected in the background surface water. Acetone, methylene chloride, and toluene were variably detected in four of the background surface water samples (SW-FC-025, BW-BK-002, SW-BK-SAIC, and BW-BK-002). Explosives and SVOCs were not detected in any of the background surface water samples.

4.6.2 Study Area 9–Aniline Sludge Basin

During Phase 1 of the Supplemental RI, one surface water sample (SW-09-028) was collected from the Aniline Sludge Basin and analyzed for metals, explosives, VOCs, and SVOCs. **Figure 4-46** shows the sampling location and the general contaminant group CEBs that were detected. **Table 4-76** presents the summary statistics for the detected constituents in the surface water at Study Area 9.

Metals—Five metals exceeded background in the Study Area 9 surface water sample, as shown in the adjacent box. Concentrations of nutrient inorganic constituents, including calcium and potassium, were detected above background in the pond sample. In addition, copper, iron, and lead were detected above background. The detected concentrations in the Study Area 9 surface water sample are presented in the adjacent box.

Maximum Concentrations**	
Analyte	μg/L
Calcium	81,400
Copper	13.6
Iron	1,570
Lead	2.97
Potassium	3,870

** ANOVA evaluation not conducted because there are fewer than four samples in the data set.

Explosives—Explosives were not detected in the surface water sample collected at Study Area 9.

VOCs—Toluene (0.6 μg/L) was the only VOC that was detected in the surface water sample. The detected concentration only slightly exceeded the CRL (0.5 μg/L).

Table 4-75. Summary Statistics and Exposure Point Concentrations for Surface Water at Study Area BK - Background
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 12:22:25 PM
Run Date: 3/31/99
Exposure Unit: BK__WS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/L	4 / 6	4 / 6	67%	141	141	114	386	155	118	Lognormal	360	360		309	--
Antimony	µg/L	2 / 6	2 / 6	33%	1.00	1.00	1.5	4.6	1.4	1.6	Lognormal	6.8	4.6	#	2.7	--
Arsenic	µg/L	1 / 6	1 / 6	17%	1.00	1.00	1.6	1.6	0.68	0.43	Lognormal	1.1	1.1		1.4	--
Barium	µg/L	7 / 7	6 / 6	100%	--	--	21	54	39	9.1	Lognormal	52	52		78	--
Calcium	µg/L	6 / 6	6 / 6	100%	--	--	19,600	43,200	31,583	8,154	Normal	38,291	38,291		63,167	--
Iron	µg/L	7 / 7	6 / 6	100%	--	--	221	446	321	87	Normal	393	393		642	--
Magnesium	µg/L	6 / 6	6 / 6	100%	--	--	5,560	14,300	9,235	3,059	Normal	11,752	11,752		18,470	--
Manganese	µg/L	7 / 7	6 / 6	100%	--	--	66	452	178	81	Normal	244	244		355	--
Potassium	µg/L	5 / 6	5 / 6	83%	1000	1000	742	1,460	1,099	412	Normal	1,438	1,438		2,197	--
Selenium	µg/L	1 / 6	1 / 6	17%	1.00	2.0	1.3	1.3	0.72	0.36	Lognormal	1.2	1.2		1.4	--
Sodium	µg/L	5 / 6	5 / 6	83%	2,290	2,290	1,550	11,500	4,278	4,395	Lognormal	26,049	11,500	#	8,555	--
Acetone	µg/L	1 / 5	1 / 5	20%	13	60	30	30	16	13	Lognormal	100	30	#	--	--
Methylene Chloride	µg/L	1 / 5	1 / 5	20%	2.3	8.0	2.6	2.6	2.0	1.3	Normal	3.2	2.6	#	--	--
Toluene	µg/L	2 / 5	2 / 5	40%	0.50	1.00	1.1	1.1	0.64	0.43	Normal	1.1	1.1		--	--

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

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was detected at Study Areas 10 (Tetryl Manufacturing Area), 20 (Rifle Powder Finishing Area), and 25 (Storage Battery/Demolition Debris).

PCBs were detected in the soils around transformers located within Study Area 2 (Smokeless Powder Facility). The density of the screening samples and the high correlation between the screening and PCB confirmatory results indicates that a very limited area of contaminated surface soil exists around the transformers.

One pesticide, heptachlor, was detected at Study Area 3 (Sanitary Landfill and Lead Facility). It was detected in one subsurface sample at a depth of 1 foot BLS and a concentration of 0.0919 µg/g. A duplicate sample collected at the same location did not contain heptachlor. The deeper samples collected at the location also were free of pesticides. Pesticides or PCBs were not detected near the Fertilizer and Pesticide Storage Building.

4.6 SURFACE WATER QUALITY ASSESSMENT

The chemical quality of surface water on and around ALAAP was assessed through quantitative sampling and analysis of water from the Red Water Ditch (Study Area 21), the Crossover Ditch (Study Area 26), the Beaver Pond Drainage System (Study Area 27), Fanning Creek, and Talladega Creek. In addition, limited sampling was conducted in Study Area 9 (Aniline Sludge Basin) and in Study Area 16 (Flashing Ground). Because of the high water discharge associated with the Coosa River, limited surface water sampling was conducted directly from the river. Surface streams discharging directly into the Coosa River from ALAAP were sampled at their confluence with the river.

4.6.1 Background Surface Water Quality

Surface water samples from five background locations (BK-BW-002, SW-BK-SAIC, SW-FC-025, SW-FC-026, and SW-FC-027) were obtained from streams that are located north and south of the facility with ultimate drainage to the Coosa River (**Figure 4-45**). The samples were analyzed for metals, explosives; VOCs, and SVOCs. Summary statistics for the background surface water samples from four locations on Fanning Creek (SW-FC-025, SW-FC-026, SW-FC-027, BW-BK-002) and one location on Talladega Creek (SW-BK-SAIC) are shown in **Table 4-75**.

Metals—Aluminum (114 to 386 µg/L), antimony (1.54 to 4.6 µg/L), arsenic (1.55 µg/L), barium (21.4 to 53.6 µg/L), iron (221 to 446 µg/L), manganese (66.4 to 452 µg/L), and selenium (1.33 µg/L) were detected in the background surface water. Concentrations of essential nutrient metals that were detected in the background samples included calcium (19,600 to 43,200 µg/L), magnesium (5,560 to 14,300 µg/L), potassium (742 to 1,460 µg/L), and sodium (1,550 to 11,500 µg/L).

Supplemental RI and were subsequently excavated and treated by onsite incineration. Other explosives were present in soils at relatively low concentrations. There were no target explosives detected in laboratory confirmatory samples in the soils at Study Area 4 (Manhattan Project Area), the eastern portion of Study Area 10 (Tetryl Manufacturing Area), Study Area 19 (Lead Facility), and Study Area 25 (Storage Battery/Demolition Debris). One nontarget explosive compound (HMX) was detected in the subsurface soil in the eastern portion of Study Area 10 and in the subsurface soil at Study Area 8 (Acid/Organic Manufacturing Area). The maximum concentration of HMX detected in the subsurface soils at ALAAP was 0.551 μg/g. There is no historical information that HMX was manufactured or handled during the production years at ALAAP. Results from screening samples indicated that either explosives were not present or that they were present at very low concentrations (less than 5 μg/g) in surface and subsurface soils at the CERFA sites.

VOCs were detected in either surface or subsurface soils at all study areas and the Coke Oven. Eight VOCs were detected in soils sampled from the study areas; one additional VOC (chlorobenzene) was detected in the soils collected from the background locations. Many VOC detections were at concentrations near or below the CRL. Acetone concentrations detected before June 19, 1995, are believed to be related to field laboratory contamination. Soils sampled from 13 study areas and the Coke Oven contained acetone concentrations greater than 0.1 μg/g. The highest concentrations of acetone were detected in the 1- to 10-foot BLS soil interval in most cases (except for Study Areas 8, 25, and the Coke Oven). In these subsurface soil samples, acetone was either not detected or was detected at concentrations near the CRL in the corresponding surface soils. The deep subsurface soils generally contained much lower, but detectable, concentrations than soils sampled from the 1- to 10-foot interval. Soils sampled at the Coke Oven contained some of the highest concentrations of acetone (2.2 μg/g) in the greater than 10-foot BLS soil interval. Toluene was detected in soils sampled from every study area and at the Coke Oven. Toluene was detected in both surface and subsurface soils and is most likely related to site activities during the active period of the installation. There is no clear distribution pattern with respect to the migration of toluene through the soils. However, toluene was detected in nearly half of the samples collected from the shallow subsurface, and also frequently detected in the surface and deep subsurface soils.

Twenty-five SVOCs, 17 of which are PAHs, were detected in the soils at Area B of ALAAP. Several SVOCs were detected at Study Areas 2 (Smokeless Powder Facility), 3 (Sanitary Landfill and Lead Facility), 4 (Manhattan Project Area), 6 (Southern TNT Manufacturing Area), 8 (Acid/Organic Manufacturing Area), 16 (Flashing Ground), and 22 (Demolition Landfill). SVOC concentrations were the highest at Study Area 22, and may be related to the placement of demolition debris from the burning of all buildings onsite. The Demolition Landfill also may have received chemicals from the materials testing laboratories or those used in the manufacture of explosives, acids, or organics. Twelve SVOCs were detected at one UST located within Study Area 2 (Smokeless Powder Facility), with all concentrations less than 2 μg/g. SVOCs were not detected in soils sampled from Study Areas 7 (Northern TNT Manufacturing Area), 17 (Propellant Shipping Area), 18 (Blending Tower Area), and 19 (Lead Facility). Only one SVOC

Table 4-74. Chemicals Exceeding Background in Soil (continued)
Alabama Army Ammunition Plant, Childersburg, Alabama

	Study Area																	CERFA			
Chemicals[a]	2	3	4	6	7	8	8T[d]	10E	10W	16	17	18	19	20	22	25	BK	Coke Oven	Utility Poles	USTs and Gas Station	Pesticide Storage
SVOCs																			N/A		N/A
2-methylnaphthalene	1					1				1					2						
4-Methylphenol	1																				
Acenaphthene	1					1				1					2						
Acenaphthylene						1															
Anthracene	1	1	2			1				1					2					2	
Benzo(a)anthracene	1,2	1,2	1,2	2		1,2				1,2					2			1		2	
Benzo(a)pyrene	1,2	1	1,2	2		1,2				1,2					2					2	
benzo(b)fluoranthene	1,2	1	1,2	2		1,2				1,2					2					2	
benzo(g,h,i)perylene	1,2	1	1	2		1				1					2					2	
Benzo(k)fluoranthene	1	1	1	2		1				1,2					2					2	
Benzoic Acid				3		1		1								1					
Bis(2-ethyl) phthalate		2				1															
Chrysene	1,2	1	1,2	2		1,2				1,2					2					2	
di-n-butyl-phthalate										1,2							1				
Dibenzo(a,h)anthracene	1					1				1					2						
Dibenzofuran	1					1				1					2						
Diethyl phthalate										3											
Fluoranthene	1,2	1	1,2	2		1,2				1,2				1	2					2	
Fluorene	1					1				1					2						
Indeno(1,2,3-cd)pyrene	1,2	1	1	2		1,2				1					2					2	
N-nitrosodiphenylamine						1				1										2	
Nathphalene	1					1				1					2						
Phenanthrene	1,2	1,2	1,2			1,2				1,2					2			1		2	
Phenol							2,3														
Pyrene	1,2	1	1	2		1,2				1					2					2	

[a] Values in table are depths where chemical exceeded background. 1=0-1 ft; 2=1-10ft; 3= >10ft

b Metals that were present in background soils

c N/A = Not Applicable

d8T = Study Area 8 Test Pits

Table 4-74. Chemicals Exceeding Background in Soil (continued)
Alabama Army Ammunition Plant, Childersburg, Alabama

	Study Area																	CERFA			
Chemicals[a]	2	3	4	6	7	8	8T[d]	10E	10W	16	17	18	19	20	22	25	BK	Coke Oven	Utility Poles	USTs and Gas Station	Pesticide Storage
Explosives																			N/A		N/A
1,3,5-Trinitrobenzene				3	1,2		NA		2	2											
1,3-Dinitrobenzene	1						NA														
2,4,6-Trinitrotoluene				1,2,3	1,2,3	2	NA		2	2					2		1				
2,4-Dinitrotoluene	1,2,3	1		3	1	1,2,3	NA			2	1,3	1		1,2,3	2						
2,6-Dinitrotoluene	2			1	1		NA		1	2											
2-Amino-4,6-dinitrotoluene				1			NA		1	2											
4-Amino-2,6-dinitrotoluene							NA			2											
HMX						2	NA	3													
Nitrobenzene				1	1		NA														
Tetryl				1,2	1	1	NA		1,2	2											
VOCs																			N/A	N/A	N/A
Acetone	2	1,2,3	2,3	2,3	2	2,3		2,3		2,3	3	2,3	2		1	1	1,2,3	1,2,3			
Benzene						2,3											1				
Chlorobenzene																	1				
Chloroethane										2											
Ethylbenzene				3																	
Methylene chloride	2,3	1,2,3	3		2			3		1,2	3		1	2,3	1,2	2,3		1,2,3			
Methylethyl ketone		3																			
Styrene						1															
Toluene	1	1,2,3	2,3	2,3	2	1,2,3		2,3		1,2,3	1,2,3	1,2	1,2,3	1,2	1,2,3	1,2	1,2,3	1,2,3			
PCB/Pesticides																		N/A		N/A	
Aroclor 1248																			1		
Aroclor 1254																			1		
Aroclor 1260																			1,2		
Heptachlor		2																			

Table 4-74. Chemicals Exceeding Background in Soil
Alabama Army Ammunition Plant, Childersburg, Alabama

	Study Area																	CERFA			
Chemicals[a]	2	3	4	6	7	8	8T[d]	10E	10W	16	17	18	19	20	22	25	BK	Coke Oven	Utility Poles	USTs and Gas Station	Pesticide Storage
Inorganics																			N/A[c]		
Aluminum	1,2,3	1	1		2,3	1,2	3	3		1	1			1,2,3		1,3	1,2,3	1			1
Antimony							2,3														
Arsenic	1	1				1	2,3	1		1,3	1,2,3	1	2	1	2	1	1,2,3	1			
Barium	1,2,3	1	1,2,3	3	2,3	1,2,3	2,3	1,2,3		1,2	1	2		1,2,3	1,2	2,3	1,2,3	1			1
Beryllium	1,2,3	1,2,3	1,3	3	2,3	1,2,3		1,2,3		2	1,2,3			1,3	1,2,3	1,2,3	1,2,3	1			1,2
Cadmium										1,2			2		1,2						1
Calcium	1,2,3	1,2,3	1,2,3	3	2,3	1,2,3	3	3		2	1,3			1,3	1,2	3	1,2,3				
Chromium	1	2				2,3	2,3	2,3			2	1,2	1	1	1,2	1	1,2,3			2	
Cobalt	2	1,2	2	2	2	1,2		2		1,2		2		2	2	2	1,2,3				
Copper	1	1	1			1,2	2			1,2	1	3			1,2	1,2,3	1,2,3	1			1,2
Iron	1,2,3	1,2,3		3		1,2,3	2,3	1,2		1	1	1		1,2,3	2	1,3	1,2,3	1		2	1,2
Lead	1,2,3	1,2	1,2,3	1,2,3	1,2,3	1,2,3	2	1,2,3	1,2	1,2	2	2	1,2,3	2,3	1,2,3	1,2,3	1,2,3	1			1
Magnesium	1,2,3	1	1	2,3	2,3	1,2,3		3		1,2	1			1,3	1,2	2,3	1,2,3	1			
Manganese	1,2,3	2			2,3	1,2		1,2,3			1,2	1,2		1,3	2	2,3	1,2,3				1,2
Mercury	1,2	1,2	1,2			1				1,2					1,2	1	1,2,3	1			1
Molybdenum						1				3	3				2					2	
Nickel	1	1	1		3	1,2		3		1	1,2			1	1,2,3	1,2	1,2,3	1			1
Nitrate																	2				1
Potassium	1,2	1	1	2,3	2,3	1,2,3		3		1	1			1	1,2	1,2,3	1,2,3				
Phosphate																	2				
Selenium				3													1				
Silver																					
Sodium	1,2,3	2,3	1,3	3	2,3	2,3	3	2,3		2	2			2,3	2	2	1				
Thalium	3																				
Vanadium	1	1			2	1,2,3	2,3	2		1		1		1,2,3		1	1,2,3	1		2	2
Zinc	1	2	1		2	1,2				1,2			1		1,2	1	1,2,3	1			1

Twenty-three of the 24 metals on the target analyte list exceeded background concentrations in the soils at the study areas and CERFA sites investigated at ALAAP. Silver was the only metal on the target analyte list that was not detected in the soils at ALAAP. Likewise, silver was not detected in the background soils. A summary of this information is shown in **Table 4-74**. All study areas where metals analyses were conducted contained at least one metal that exceeded background concentrations. Study Area 2 (Smokeless Powder Facility) and Study Area 8 (Acid/Organic Manufacturing Area) contained the most metals (19) exceeding background concentrations. The manufacture of smokeless powder, which frequently included the addition of powdered metals such as barium, aluminum, magnesium, and manganese, is a potential source of metals at Study Area 2. The manufacture of acids and organics at Study Area 8 is suspected to be the source of the metals present as a result of the extraction of metals from containers, piping, storage bins, and other equipment. Study Areas 3 (Sanitary Landfill and Lead Facility), 16 (Flashing Ground), 22 (Demolition Landfill), and 25 (Storage Battery/Demolition Debris) also contained a high number of metals exceeding background. This occurrence can be attributed to the use of these study areas as debris disposal areas for a variety of rejected waste, open burning of refuse, and flashing of contaminated metals.

Each of the study areas where subsurface soil samples were collected contained metals at concentrations that exceeded background. Twenty-three different CEB metals were detected in the subsurface soils. The most pervasive CEB metals detected in the soils at ALAAP were barium and lead. Lead was detected above background in the soils at every study area and barium was detected above background at every study area except Study Area 19 (Lead Facility). Barium analysis was not conducted on the soils collected from the western portion of Study Area 10 (Tetryl Manufacturing Area). The presence of lead is believed to be related to site activities during the active period of ammunition production. Lead is used in the production processes for explosives (e.g., nitrators, drying pans, bearing metal), ammunition (e.g., preparation of oxides and salts for explosive mixtures), and TNT (typically uses an initiator made of lead or lead azide). Although there is no historical data or information pertaining to the use of metals other than lead, during World War II powdered metals such as barium, aluminum, magnesium, and manganese frequently were mixed with explosives or smokeless powder to enhance their effectiveness (Federoff 1960). The pervasive presence of barium can likely be attributed to these processes.

Nine target explosives and one nontarget explosive compound (HMX) were detected in the soils sampled at ALAAP. The most pervasive explosive detected was 2,4-DNT, which was present in confirmatory samples collected from 10 of 14 study areas. In general, Phase 1 2,4-DNT concentrations were low (less than 3 μg/g), except at Study Areas 2 (Smokeless Powder Facility), 16 (Flashing Ground), and 17 (Propellant Shipping Area). In each of these three study areas, significant explosives contamination was limited to the surface soils. The horizontal extent of contamination also was limited. This finding is based on the number of screening samples collected and analyzed, and the high correlation between the screening and laboratory confirmatory results. The explosives at these three study areas were identified during Phase 1 of the

concentrations greater than background. Nitrate was detected in each of the five surface soil samples collected, and ranged in concentrations from 1.13 to 12.5 µg/g. Phosphate concentrations varied from nondetect to 291 µg/g in the surface soil samples.

Twelve metals were detected in the shallow subsurface soils at concentrations that exceeded background, while nine metals were detected above background concentrations in the deep subsurface soils. In general, metal concentrations decreased with increasing depth, with the exception of aluminum, calcium, copper, and iron.

	Maximum Concentrations*		
Analyte (µg/g)	0-<1ft	1-10ft	>10ft**
Aluminum	**31,000**	37,000	29,000
Arsenic	19.4		
Barium	**363**	156	55.4
Beryllium	**5.89**	**3.53**	2.04
Cadmium	**1.30**		
Calcium	**140,000**	**60,000**	7,120
Chromium	59.6	**133**	
Copper	**27.4**		
Iron	**47,000**	**94,000**	60,000
Lead	**212**	145	36.3
Magnesium	**28,000**	5,580**	2,390
Manganese		1,100	
Mercury	**0.163**		
Nickel	**14.7**		
Nitrate	**12.5**		
Phosphate	**291**		
Potassium	**4,710**	**4,100**	1,490
Sodium	744	**482**	132
Vanadium		**140**	
Zinc	**542**		

* Metals also determined to exceed background based on ANOVA evaluation are shown in bold.

** ANOVA evaluation was not conducted because there are fewer than four samples in the data set.

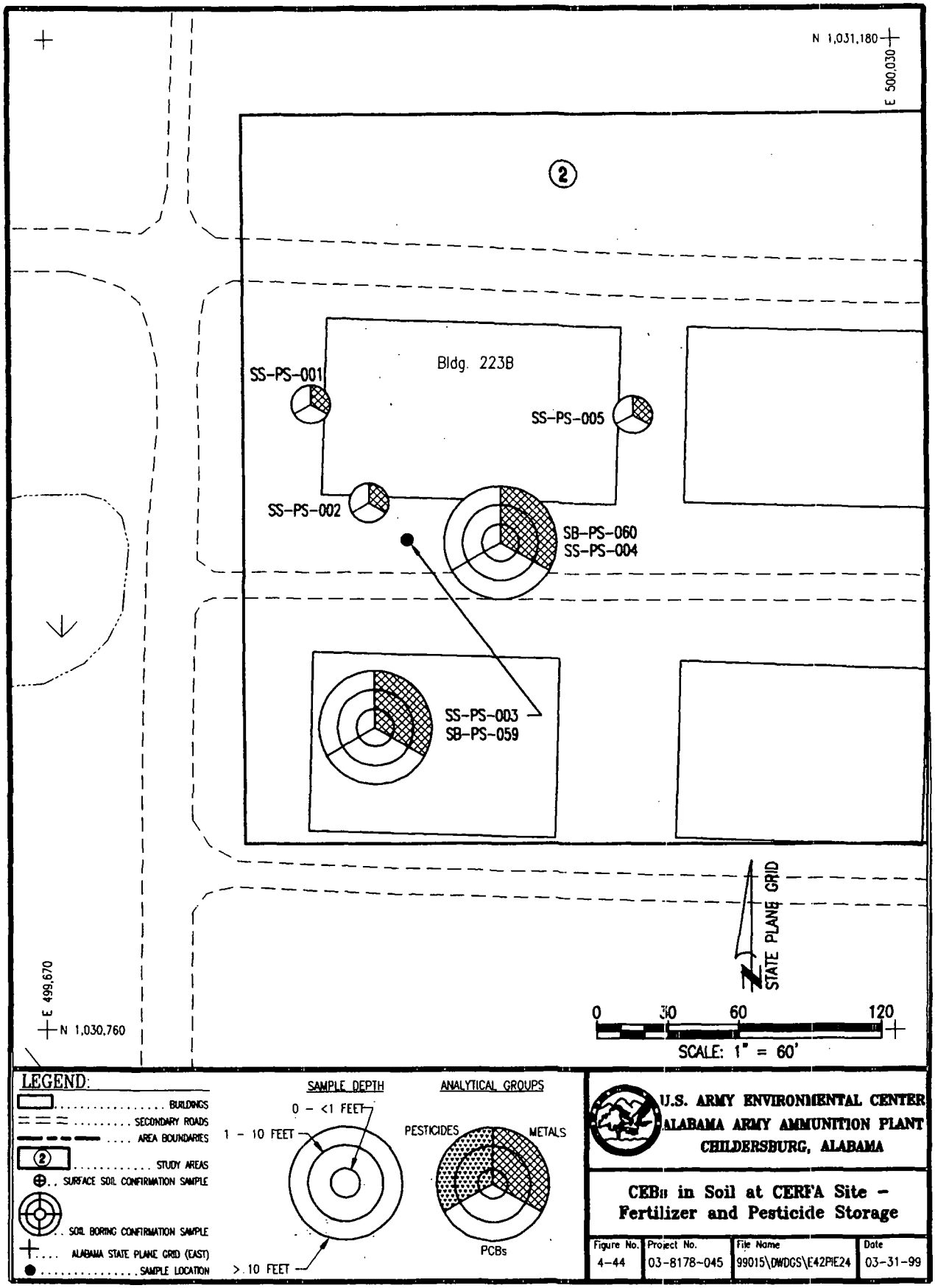
Pesticides—Pesticides were not detected in any of the surface or subsurface soil samples collected at the Fertilizer and Pesticide Storage Building.

PCBs—PCBs were not detected in any of the surface or subsurface soil samples collected at the Fertilizer and Pesticide Storage Building.

Summary—Based on data collected during the Supplemental RI, neither pesticides nor PCBs have been released to soils at the Fertilizer and Pesticide Storage Building. However, soils at the Fertilizer and Pesticide Storage Building contain metals at concentrations in excess of background. Metals were detected at concentrations exceeding background in all intervals of soils sampled (i.e., surface, shallow subsurface, and deep subsurface). In general, metals concentrations detected in the soils sampled from this study area decreased with increasing depth. Nitrate and phosphate were detected in the surface soils at concentrations that varied from 1.13 to 12.5 µg/g and nondetect to 291 µg/g, respectively.

4.5.21 Summary of Soil Results

Soil samples were collected from study areas and CERFA sites at ALAAP and analyzed for target metals and organics, including nitroaromatic compounds, to determine if previous manufacturing and industrial processes have impacted the soils. Samples were collected from both the surface and subsurface. Background locations were identified and sampled. Nineteen metals from the target analyte list, in addition to nitrate and phosphate, were present in the background soils. Each of the metals detected in the background surface soils also were detected in background subsurface soils, except for selenium and sodium.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E 500,030
2
Bldg. 223B
SS-PS-001
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SS-PS-002
SB-PS-060
SS-PS-004
SS-PS-003
SB-PS-059
STATE PLANE GRID
E 499,670
N 1,030,760
0 30 60 120
SCALE: 1" = 60'
LEGEND:
BUILDINGS
SECONDARY ROADS
AREA BOUNDARIES
STUDY AREAS
SURFACE SOIL CONFIRMATION SAMPLE
SOIL BORING CONFIRMATION SAMPLE
ALABAMA STATE PLANE GRID (EAST)
SAMPLE LOCATION
SAMPLE DEPTH
0 - <1 FEET
1 - 10 FEET
>10 FEET
ANALYTICAL GROUPS
PESTICIDES
METALS
PCBs
U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA
CEBs in Soil at CERFA Site -
Fertilizer and Pesticide Storage
Figure No. 4-44
Project No. 03-8178-045
File Name 99015\DWDGS\E42PIE24
Date 03-31-99

Table 4-73. Summary Statistics and Exposure Point Concentrations for Soil (>10 ft BLS) at Study Area PS - Fertilizer and Pesticide Storage Building
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 7:25:58 PM
Run Date: 3/29/99
Exposure Unit: PS_SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	2 / 2	2 / 2	100%	--	--	25,000	29,000	--	--	Undetermined	--	29,000	#	27,567	[CEB]
Arsenic	µg/g	2 / 2	2 / 2	100%	--	--	20	24	--	--	Undetermined	--	24	#	52	[bk]
Barium	µg/g	2 / 2	2 / 2	100%	--	--	50	55	--	--	Undetermined	--	55	#	41	[CEB]
Beryllium	µg/g	2 / 2	2 / 2	100%	--	--	1.9	2.0	--	--	Undetermined	--	2.0	#	0.89	[CEB]
Calcium	µg/g	2 / 2	2 / 2	100%	--	--	4,850	7,120	--	--	Undetermined	--	7,120	#	257	[CEB]
Chromium	µg/g	2 / 2	2 / 2	100%	--	--	27	31	--	--	Undetermined	--	31	#	53	[bk]
Cobalt	µg/g	2 / 2	2 / 2	100%	--	--	5.4	19	--	--	Undetermined	--	19	#	58	[bk]
Copper	µg/g	2 / 2	2 / 2	100%	--	--	24	35	--	--	Undetermined	--	35	#	56	[bk]
Iron	µg/g	2 / 2	2 / 2	100%	--	--	42,000	60,000	--	--	Undetermined	--	60,000	#	57,000	[CEB]
Lead	µg/g	2 / 2	2 / 2	100%	--	--	32	36	--	--	Undetermined	--	36	#	32	[CEB]
Magnesium	µg/g	2 / 2	2 / 2	100%	--	--	1,570	2,390	--	--	Undetermined	--	2,390	#	867	[CEB]
Manganese	µg/g	2 / 2	2 / 2	100%	--	--	272	450	--	--	Undetermined	--	450	#	1,331	[bk]
Nickel	µg/g	2 / 2	2 / 2	100%	--	--	24	25	--	--	Undetermined	--	25	#	46	[bk]
Potassium	µg/g	2 / 2	2 / 2	100%	--	--	1,230	1,490	--	--	Undetermined	--	1,490	#	1,206	[CEB]
Sodium	µg/g	2 / 2	2 / 2	100%	--	--	109	132	--	--	Undetermined	--	132	#	--	[CEB]
Vanadium	µg/g	2 / 2	2 / 2	100%	--	--	59	72	--	--	Undetermined	--	72	#	92	[bk]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-72. Summary Statistics and Exposure Point Concentrations for Soil (1-10 ft BLS) at Study Area PS - Fertilizer and Pesticide Storage Building
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 7:25:57 PM
Run Date: 3/29/99
Exposure Unit: PS_SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	4 / 4	4 / 4	100%	--	--	23,000	37,000	32,250	6,397	Normal	39,777	37,000	#	27,733	[CEB][ANOVA]
Arsenic	µg/g	3 / 4	3 / 4	75%	13	13	22	32	21	11	Normal	34	32	#	42	[bk]
Barium	µg/g	3 / 4	3 / 4	75%	4.9	4.9	143	156	112	73	Lognormal	6.13E+09	156	#	64	[CEB][ANOVA]
Beryllium	µg/g	4 / 4	4 / 4	100%	--	--	1.7	3.5	2.6	0.83	Normal	3.6	3.5	#	0.80	[CEB]
Calcium	µg/g	4 / 4	4 / 4	100%	--	--	17,000	60,000	36,000	17,795	Normal	56,939	56,939		2,475	[CEB]
Chromium	µg/g	4 / 4	4 / 4	100%	--	--	36	133	72	42	Normal	122	122		46	[CEB]
Cobalt	µg/g	1 / 4	1 / 4	25%	2.5	2.5	4.2	4.2	2.0	1.5	Lognormal	8.7	4.2	#	7.0	[bk]
Copper	µg/g	4 / 4	4 / 4	100%	--	--	18	25	21	3.2	Normal	25	25	#	26	[bk]
Iron	µg/g	4 / 4	4 / 4	100%	--	--	52,000	94,000	70,000	20,461	Normal	94,076	94,000	#	52,000	[CEB]
Lead	µg/g	3 / 4	3 / 4	75%	10.0	10.0	33	145	56	61	Normal	128	128		14	[CEB][ANOVA]
Magnesium	µg/g	3 / 3	3 / 3	100%	--	--	2,880	5,580	--	--	Undetermined	--	5,580	#	1,399	[CEB]
Manganese	µg/g	4 / 4	4 / 4	100%	--	--	520	1,100	853	254	Normal	1,151	1,100	#	682	[CEB][ANOVA]
Nickel	µg/g	3 / 4	3 / 4	75%	7.5	7.5	12	20	13	6.9	Normal	21	20	#	21	[bk]
Potassium	µg/g	4 / 4	4 / 4	100%	--	--	1,420	4,100	2,605	1,111	Normal	3,912	3,912		1,324	[CEB]
Sodium	µg/g	4 / 4	4 / 4	100%	--	--	171	482	271	143	Normal	439	439		--	[CEB]
Vanadium	µg/g	4 / 4	4 / 4	100%	--	--	76	140	109	27	Normal	141	140	#	96	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-71. Summary Statistics and Exposure Point Concentrations for Soil (0-<1 ft BLS) at Study Area PS - Fertilizer and Pesticide Storage Building
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 7:25:57 PM
Run Date: 3/29/99
Exposure Unit: PS_SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[g]	Background Comparison[g]
Aluminum	µg/g	5 / 5	5 / 5	100%	--	--	14,000	31,000	24,400	6,656	Normal	30,746	30,746		20,277	[CEB]
Arsenic	µg/g	2 / 5	2 / 5	40%	13	13	18	19	11	6.9	Lognormal	31	19	#	15	[CEB][ANOVA]
Barium	µg/g	5 / 5	5 / 5	100%	--	--	283	363	329	33	Normal	361	361		124	[CEB]
Beryllium	µg/g	5 / 5	5 / 5	100%	--	--	2.3	5.9	3.9	1.4	Normal	5.2	5.2		0.82	[CEB]
Cadmium	µg/g	3 / 5	3 / 5	60%	0.43	0.43	0.78	1.3	0.70	0.48	Normal	1.2	1.2		--	[CEB]
Calcium	µg/g	5 / 5	5 / 5	100%	--	--	31,000	140,000	75,200	41,499	Normal	114,765	114,765		4,960	[CEB]
Chromium	µg/g	5 / 5	5 / 5	100%	--	--	11	60	26	20	Normal	45	45		54	[CEB][ANOVA]
Cobalt	µg/g	2 / 5	2 / 5	40%	2.5	2.5	4.2	5.2	2.6	1.9	Normal	4.5	4.5		14	[bk]
Copper	µg/g	5 / 5	5 / 5	100%	--	--	12	27	21	5.5	Normal	26	26		13	[CEB]
Iron	µg/g	5 / 5	5 / 5	100%	--	--	27,000	47,000	35,200	8,167	Normal	42,986	42,986		37,560	[CEB]
Lead	µg/g	5 / 5	5 / 5	100%	--	--	21	212	93	76	Normal	166	166		34	[CEB]
Magnesium	µg/g	5 / 5	5 / 5	100%	--	--	4,150	28,000	13,370	9,161	Normal	22,104	22,104		1,189	[CEB]
Manganese	µg/g	5 / 5	5 / 5	100%	--	--	710	1,400	1,020	313	Normal	1,318	1,318		1,730	[bk]
Mercury	µg/g	2 / 5	2 / 5	40%	0.087	0.087	0.11	0.16	0.080	0.054	Normal	0.13	0.13		0.056	[CEB]
Nickel	µg/g	4 / 5	4 / 5	80%	7.5	7.5	9.3	15	11	4.3	Normal	15	15	#	9.4	[CEB]
Potassium	µg/g	5 / 5	5 / 5	100%	--	--	2,240	4,710	3,298	965	Normal	4,218	4,218		680	[CEB]
Sodium	µg/g	5 / 5	5 / 5	100%	--	--	239	744	429	193	Normal	613	613		501	[CEB][ANOVA]
Vanadium	µg/g	5 / 5	5 / 5	100%	--	--	32	71	44	15	Lognormal	64	64		76	[bk]
Zinc	µg/g	5 / 5	5 / 5	100%	--	--	96	542	274	171	Normal	438	438		36	[CEB]
Nitrate	µg/g	5 / 5	5 / 5	100%	--	--	1.1	13	5.1	4.7	Normal	9.6	9.6		--	[CEB]
Phosphate	µg/g	4 / 5	4 / 5	80%	5.0	5.0	11	291	97	116	Normal	208	208		--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

SS-US-004, collected from 5 feet BLS. With the exception of fluoranthene (1.40 µg/g), concentrations of all the SVOCs were less than 1 µg/g. These results indicate that low concentrations of residual petroleum products remain in the subsurface soils at Building 302B.

Summary—A variety of metals were detected in the soils near the former UST locations at concentrations greater than background. Lead was detected at six of the nine UST sampling locations at concentrations that exceeded background. The maximum lead concentration detected in subsurface soils was 35.1 µg/g at a depth of 5 feet BLS at Building 302B. Soils sampled from the former Gas Station contained only two metals (lead and molybdenum) at concentrations greater than background.

Twelve SVOCs were detected in soils collected in the vicinity of a former UST located outside Building 302B. With the exception of fluoranthene (1.40 µg/g), concentrations of all of the SVOCs were less than 1 µg/g. The results indicate that low concentrations of petroleum-related organic compounds exist at the former UST near Building 302B. Petroleum-related organic compounds were not detected at the former Gas Station or at the former USTs outside the Guard Post and Building 715C. All USTs have been removed from the site.

4.5.20 Fertilizer and Pesticide Storage Building

According to the CERFA Report (TETC 1994), Building 223B was used to store fertilizer and pesticides. The building was leased approximately 20 years ago by the Parker Fertilizer Company (Sylacauga, Alabama) for storage. The building was cleaned out when demolition activities began at ALAAP (circa 1991). No releases have been reported.

Five soil sampling locations were established in the yard area of the Fertilizer and Pesticide Storage Building to identify potential releases from activities conducted at the building. Surface soil samples were collected from all five locations. Two shallow subsurface soil samples and one deep subsurface soil sample were collected from each of two soil borings. All samples were analyzed for metals, nitrate, phosphate, pesticides, and PCBs.

Appendix K presents data summary tables for soils at the Fertilizer and Pesticide Storage Building. **Tables 4-71** through **4-73** present summary statistics for soils. **Figure 4-44** shows the locations where the general contaminant group CEBs (metals, pesticides, and PCBs) were detected in soils. Nitrate and phosphate data are included with the metals data.

Metals—Eighteen metals, as well as nitrate and phosphate, were detected at concentrations that exceed background concentration in soils at the Fertilizer and Pesticide Storage Building. The maximum concentrations of these metals are shown in the adjacent box. Most of the highest concentrations for the metals determined to exceed background concentrations were detected in samples SS-PS-001 and SS-PS-003. Each of the surface soil samples contained metals at

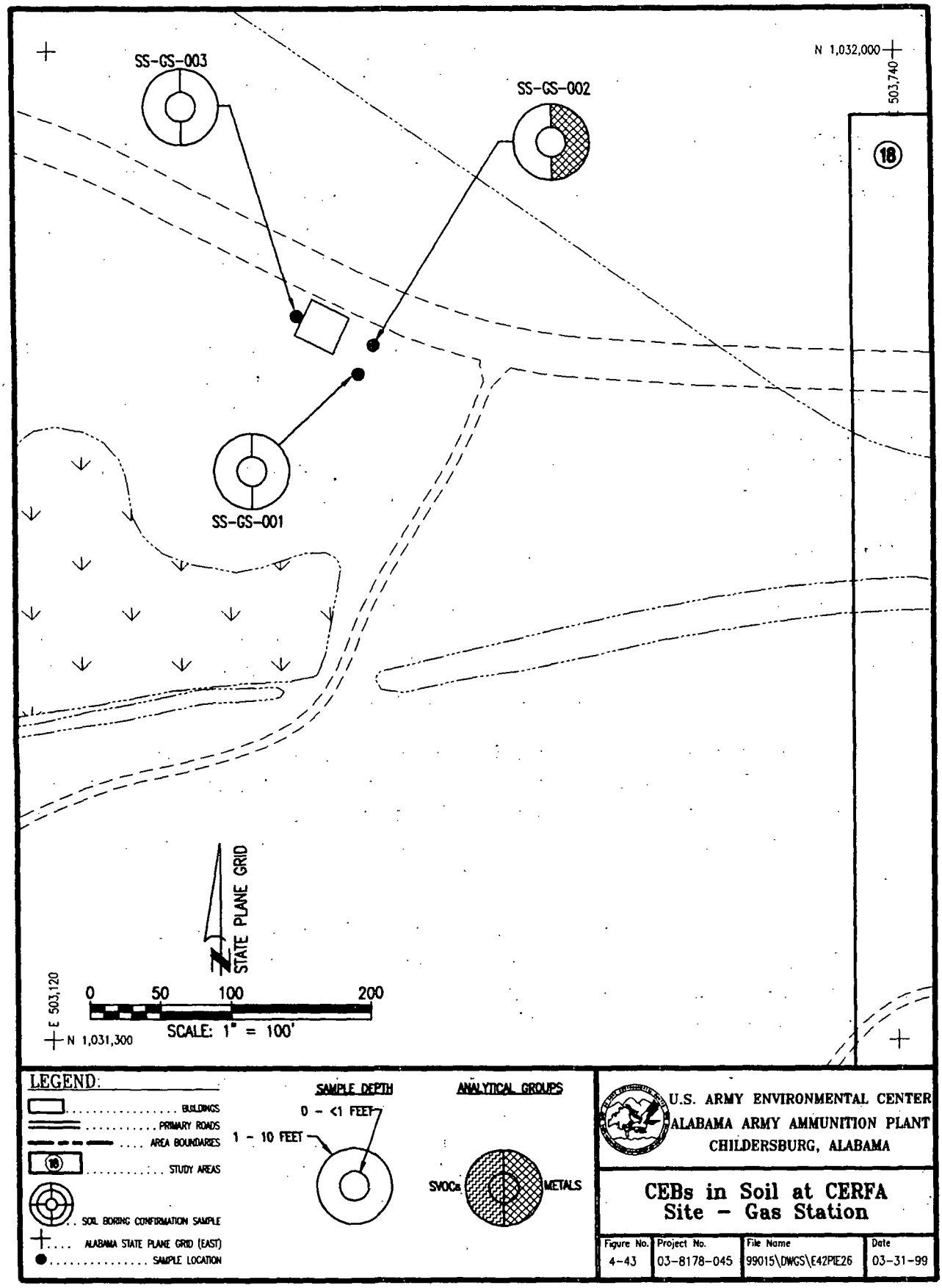

SS-GS-003
SS-GS-002
SS-GS-001
N 1,032,000
503,740
18
STATE PLANE GRID
0 50 100 200
SCALE: 1" = 100'
E 503,120
N 1,031,300
LEGEND:
BUILDINGS
PRIMARY ROADS
AREA BOUNDARIES
STUDY AREAS
SOIL BORING CONFIRMATION SAMPLE
ALABAMA STATE PLANE GRID (EAST)
SAMPLE LOCATION
SAMPLE DEPTH
0 - <1 FEET
1 - 10 FEET
ANALYTICAL GROUPS
SVOCs
METALS
U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA
CEBs in Soil at CERFA Site - Gas Station
Figure No. 4-43
Project No. 03-8178-045
File Name 99015\DWGS\E42PIE26
Date 03-31-99

Table 4-70. Summary Statistics and Exposure Point Concentrations for Soil (>10 ft BLS) at Study Area US - Underground Storage Tanks
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 7:33:42 PM
Run Date: 3/29/99
Exposure Unit: US_SD1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	1 / 1	1 / 1	100%	--	--	14,000	14,000	--	--	Undetermined	--	14,000	#	27,567	[bk]
Barium	µg/g	1 / 1	1 / 1	100%	--	--	77	77	--	--	Undetermined	--	77	#	41	[CEB]
Beryllium	µg/g	1 / 1	1 / 1	100%	--	--	1.00	1.00	--	--	Undetermined	--	1.00	#	0.89	[CEB]
Calcium	µg/g	1 / 1	1 / 1	100%	--	--	1,260	1,260	--	--	Undetermined	--	1,260	#	257	[CEB]
Chromium	µg/g	1 / 1	1 / 1	100%	--	--	14	14	--	--	Undetermined	--	14	#	53	[bk]
Cobalt	µg/g	1 / 1	1 / 1	100%	--	--	26	26	--	--	Undetermined	--	26	#	58	[bk]
Copper	µg/g	1 / 1	1 / 1	100%	--	--	12	12	--	--	Undetermined	--	12	#	56	[bk]
Iron	µg/g	1 / 1	1 / 1	100%	--	--	14,000	14,000	--	--	Undetermined	--	14,000	#	57,000	[bk]
Magnesium	µg/g	1 / 1	1 / 1	100%	--	--	529	529	--	--	Undetermined	--	529	#	867	[bk]
Manganese	µg/g	1 / 1	1 / 1	100%	--	--	690	690	--	--	Undetermined	--	690	#	1,331	[bk]
Nickel	µg/g	1 / 1	1 / 1	100%	--	--	12	12	--	--	Undetermined	--	12	#	46	[bk]
Potassium	µg/g	1 / 1	1 / 1	100%	--	--	817	817	--	--	Undetermined	--	817	#	1,206	[bk]
Vanadium	µg/g	1 / 1	1 / 1	100%	--	--	30	30	--	--	Undetermined	--	30	#	92	[bk]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-69. Summary Statistics and Exposure Point Concentrations for Soil (1-10 ft BLS) at Study Area US - Underground Storage Tanks
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 7:33:42 PM
Run Date: 3/29/99
Exposure Unit: US_SD1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	10 / 10	10 / 10	100%	--	--	7,100	47,000	18,020	11,430	Lognormal	27,499	27,499		27,733	[CEB][ANOVA]
Arsenic	µg/g	3 / 10	3 / 10	30%	13	13	18	29	12	9.2	Lognormal	20	20		42	[bk]
Barium	µg/g	10 / 10	10 / 10	100%	--	--	13	197	64	65	Lognormal	172	172		64	[CEB][ANOVA]
Beryllium	µg/g	5 / 10	5 / 10	50%	0.25	0.25	0.52	2.7	0.63	0.82	Lognormal	2.4	2.4		0.80	[CEB][ANOVA]
Calcium	µg/g	8 / 10	8 / 10	80%	109	109	222	33,000	5,837	10,587	Lognormal	1.36E+06	33,000	#	2,475	[CEB][ANOVA]
Chromium	µg/g	4 / 10	4 / 10	40%	17	68	21	65	27	16	Normal	36	36		46	[CEB][ANOVA]
Cobalt	µg/g	3 / 10	3 / 10	30%	2.5	2.5	3.2	4.7	2.1	1.3	Lognormal	3.1	3.1		7.0	[bk]
Copper	µg/g	7 / 10	7 / 10	70%	3.4	4.3	5.2	19	7.9	6.0	Normal	11	11		26	[bk]
Iron	µg/g	10 / 10	10 / 10	100%	--	--	1,200	66,000	34,620	20,931	Normal	46,753	46,753		52,000	[CEB][ANOVA]
Lead	µg/g	6 / 10	6 / 10	60%	10.0	10.0	16	35	17	11	Normal	23	23		14	[CEB][ANOVA]
Magnesium	µg/g	7 / 10	7 / 10	70%	138	138	399	2,620	872	900	Normal	1,393	1,393		1,399	[CEB][ANOVA]
Manganese	µg/g	10 / 10	10 / 10	100%	--	--	7.4	2,100	370	636	Lognormal	13,457	2,100	#	682	[CEB][ANOVA]
Nickel	µg/g	2 / 10	2 / 10	20%	7.5	7.5	13	20	6.2	5.5	Lognormal	9.9	9.9		21	[bk]
Potassium	µg/g	10 / 10	10 / 10	100%	--	--	221	3,510	776	1,001	Lognormal	1,658	1,658		1,324	[CEB][ANOVA]
Sodium	µg/g	7 / 10	7 / 10	70%	50	50	72	202	87	57	Normal	120	120		--	[CEB]
Vanadium	µg/g	10 / 10	10 / 10	100%	--	--	30	115	72	28	Normal	88	88		96	[CEB][ANOVA]
Zinc	µg/g	3 / 9	3 / 9	33%	13	35	30	87	27	29	Lognormal	79	79		71	[CEB][ANOVA]
Anthracene	µg/g	1 / 7	1 / 7	14%	0.17	0.17	0.19	0.19	0.100	0.040	Lognormal	0.13	0.13		--	[CEB]
Benzo(a)anthracene	µg/g	1 / 7	1 / 7	14%	0.17	0.17	0.54	0.54	0.15	0.17	Lognormal	0.32	0.32		--	[CEB]
Benzo(a)pyrene	µg/g	1 / 7	1 / 7	14%	0.24	0.24	0.36	0.36	0.15	0.091	Lognormal	0.23	0.23		--	[CEB]
Benzo(b)fluoranthene	µg/g	1 / 7	1 / 7	14%	0.73	0.73	0.85	0.85	0.43	0.18	Lognormal	0.57	0.57		--	[CEB]
Benzo(g,h,i)perylene	µg/g	1 / 7	1 / 7	14%	0.25	0.25	0.21	0.21	0.14	0.032	Lognormal	0.16	0.16		--	[CEB]
Benzo(k)fluoranthene	µg/g	1 / 7	1 / 7	14%	0.40	0.40	0.27	0.27	0.21	0.026	Lognormal	0.23	0.23		--	[CEB]
Chrysene	µg/g	1 / 7	1 / 7	14%	0.27	0.27	0.49	0.49	0.19	0.13	Lognormal	0.30	0.30		--	[CEB]
Fluoranthene	µg/g	1 / 7	1 / 7	14%	0.17	0.17	1.4	1.4	0.27	0.50	Lognormal	1.3	1.3		--	[CEB]
Indeno(1,2,3-cd)pyrene	µg/g	1 / 7	1 / 7	14%	0.17	0.17	0.20	0.20	0.10	0.043	Lognormal	0.13	0.13		--	[CEB]
N-Nitrosodiphenylamine	µg/g	1 / 7	1 / 7	14%	0.17	0.17	0.22	0.22	0.10	0.051	Lognormal	0.14	0.14		--	[CEB]
Phenanthrene	µg/g	1 / 7	1 / 7	14%	0.17	0.17	0.96	0.96	0.21	0.33	Lognormal	0.68	0.68		--	[CEB]
Pyrene	µg/g	1 / 7	1 / 7	14%	0.97	0.97	0.83	0.83	0.53	0.13	Lognormal	0.63	0.63		--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

subsurface sample (1 foot BLS) and one deep subsurface sample (25 feet BLS) were collected from the boring. All soil samples were analyzed for metals and SVOCs.

Appendix K presents data summary tables for soils at the former USTs and Gas Station. **Tables 4-69** and **4-70** present summary statistics for soils. **Figure 4-43** shows the locations where the general contaminant group CEBs (metals and SVOCs) were detected in soils. An empty circle at 0 - <1 foot BLS indicates that a soil sample was not collected at that interval.

Metals—Fourteen metals were detected in the subsurface soils at the UST sites at concentrations greater than background. Maximum concentrations detected for the metals are listed in the adjacent box. Nine of the metals (aluminum, barium, beryllium, calcium, lead, magnesium, manganese, potassium, and sodium) concentrations exceeding background concentrations at Building 302B were identified in sample SS-US-006. Samples collected from the shallow subsurface soils near Building 715C (SS-US-007 and SS-US-009) contained metals, including barium, calcium, lead, magnesium, and sodium, at concentrations greater than background. Lead and molybdenum were detected at concentrations greater than background in the soil collected from the former Gas Station at location SS-GS-002. Lead was detected at concentrations greater than background at six of the nine UST sampling locations (SS-US-004, SS-US-005, SS-US-006, SS-US-007, SS-US-009, and SB-GS-058).

Maximum Concentrations*			
Analyte (µg/g)	Gas Station 1-10 ft	USTs 1-10 ft**	USTs >10 feet **
Aluminum		47,000	
Barium		197	76.8
Beryllium		2.72	1.0
Calcium		33,000	1,260
Chromium		64.5	
Iron		66,000	
Lead	25.8	35.1	
Magnesium		2,620	
Manganese		2,100	
Molybdenum	5.24		
Potassium		3,510	
Sodium		**202**	
Vanadium		115	
Zinc		87.2	

* Metals also determined to exceed background based on ANOVA evaluation are shown in bold.

** ANOVA evaluation was not conducted because there are fewer than four samples in the data set.

One deep subsurface sample was collected near the Guard Post UST (SB-GS-058) at a depth of 25 feet BLS. Barium, beryllium, and calcium were detected at concentrations that exceeded background. The concentrations of barium, beryllium, and calcium present in the shallow subsurface soil sample collected at boring SB-GS-058 did not exceed background.

SVOCs—Twelve SVOCs were detected in subsurface soils collected in the vicinity of the former UST located outside of Building 302B. The SVOCs and their maximum concentrations are noted in the adjacent box. All detected SVOCs except N-Nitrosodiphenylamine were PAHs and all were detected in only one sample,

Maximum Concentrations*	
Analyte (µg/g)	USTs (1-10 ft)
Anthracene	0.190
Benzo(a)anthracene	0.540
Benzo(a)pyrene	0.360
Benzo(b)fluoranthene	0.850
Benzo(g,h,i)perylene	0.210
Benzo(k)fluoranthene	0.270
Chrysene	0.490
Fluoranthene	1.40
Indeno(1,2,3-cd)pyrene	0.200
N-Nitrosodiphenylamine	0.220
Phenanthrene	0.960
Pyrene	0.830

Maximum Concentrations			
Analyte (µg/g)	0-<1ft	1-10ft	>10ft
Aroclor-1248	69.3		
Aroclor-1254	23.5		
Aroclor-1260	102	0.0638	

PCBs—Three PCBs were detected in soil samples collected at the study area. The PCBs and their maximum concentrations are listed in the adjacent box. PCBs were confirmed in the soils at each of the locations where the field screening data indicated their presence. All three PCBs were detected in surface soils collected from SS-PO-094 and SS-PO-095, located south of Building 717A. In addition, Aroclor-1260 was detected at surface soil sampling locations SS-PO-026 and SS-PO-032, located adjacent to Building 714B; SS-PO-034 and SS-PO-092, located south of Building 717A; SS-PO-036, located adjacent to Building 745; and SS-PO-047, the South Transformer Storage Area. The highest concentration (102 µg/g) of Aroclor-1260 was reported at surface soil sampling location SS-PO-047. Aroclor-1260 also was present at a low concentration (0.0638 µg/g) in the shallow subsurface soil sample collected from SB-PO-057, located south of Building 717A. PCBs were not detected in deep subsurface soils.

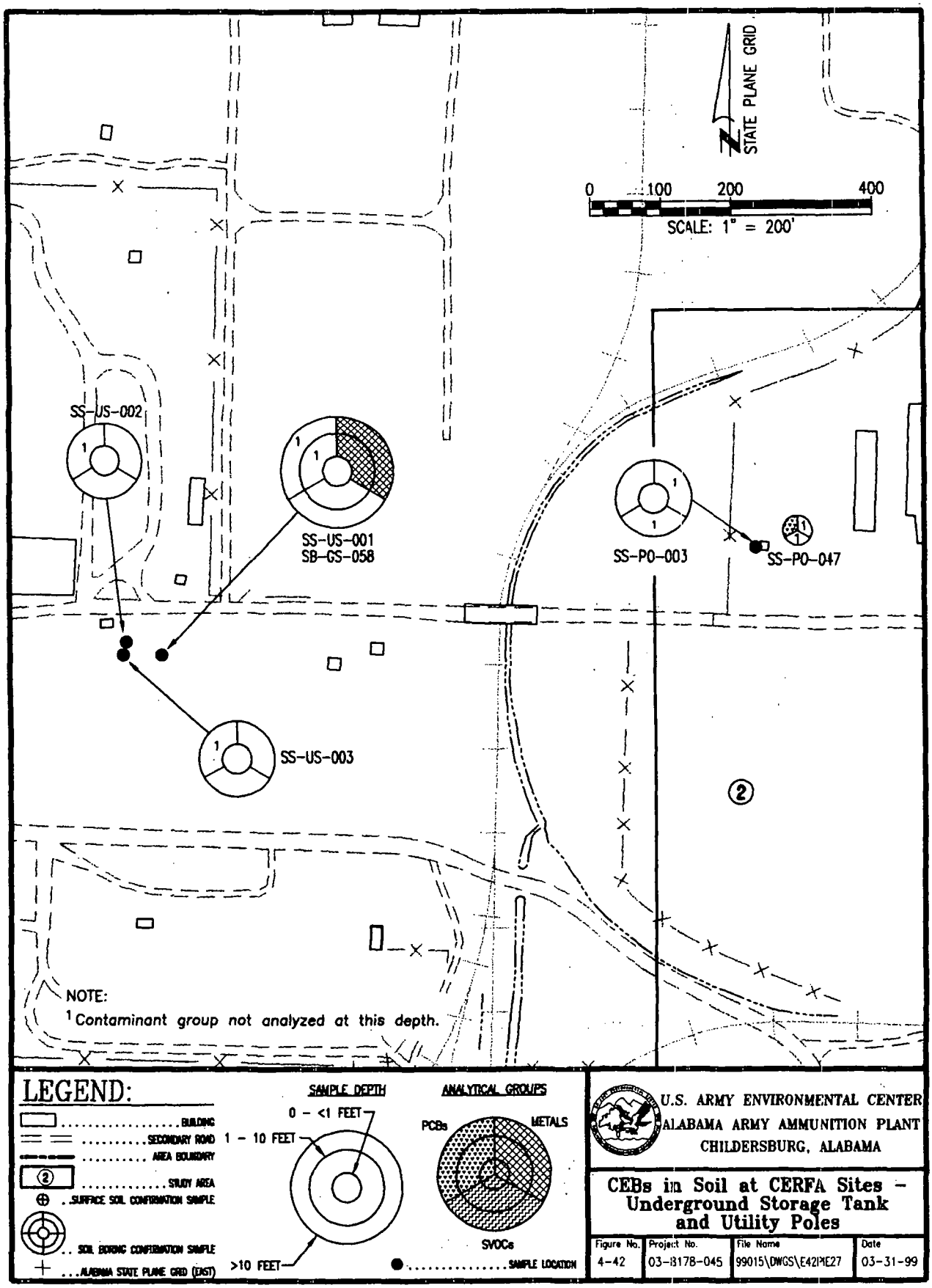
Summary—One or more of the PCBs Aroclor-1248, Aroclor-1254, and Aroclor-1260 were detected in soils at sampling locations adjacent to Building 714B, south of Building 717A, adjacent to Building 745, and in the eastern yard area of the South Transformer Storage Area. The areal and vertical extent of contamination associated with the transformer storage areas and the utility poles identified at the facility seem to be limited to very small areas. As anticipated from their high molecular weights and log/octanol water partition coefficients, detection of PCBs was restricted to surface and shallow subsurface soils (1 foot BLS).

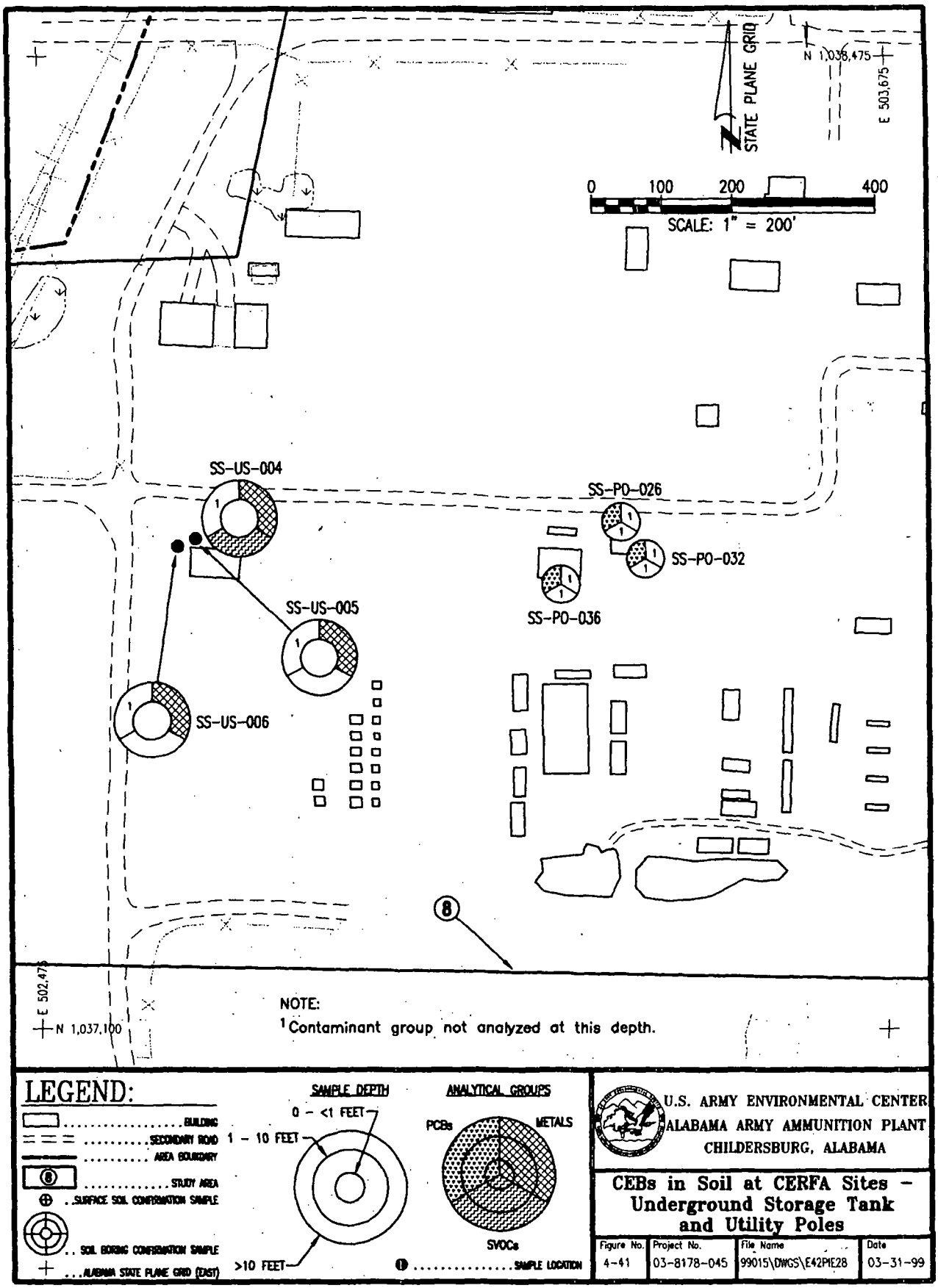
4.5.19 Underground Storage Tanks and Gas Station

According to the CERFA Report (TETC 1994), two underground storage tanks (USTs), one near Building 302B and one near Building 715C (a flammable materials storehouse southwest of Building 717A) have been removed. One of the USTs contained gasoline, and the other contained diesel fuel; each had a capacity of 12,000 gallons. During the field investigation, a third potential UST site was identified at the southern end of the site near the Guard Post. The Guard Post UST site was included in this investigation.

According to an Inventory of Military Real Property reviewed for the CERFA Report (TETC 1994), one gas station was located in Area B. Building 724E is described as a Gas Station without a building (i.e., pump station). The only information available stated that the USTs were installed in 1942. All USTs have been removed.

To investigate the potential for residual fuel contamination resulting from USTs and operations at the Gas Station, 12 subsurface soil sampling locations were established at the sites, and samples were collected at a depth of 5 feet BLS at each location. In addition, one soil boring (SB-GS-058) was drilled in the vicinity of the former UST at the Guard Post. One shallow


STATE PLANE GRID
0 100 200 400
SCALE: 1" = 200'
SS-US-002
SS-US-001
SB-GS-058
SS-US-003
SS-PO-003
SS-PO-047
NOTE:
[1] Contaminant group not analyzed at this depth.
LEGEND:
BUILDING
SECONDARY ROAD
AREA BOUNDARY
STUDY AREA
SURFACE SOIL CONFIRMATION SAMPLE
SOIL BORING CONFIRMATION SAMPLE
ALABAMA STATE PLANE GRID (EAST)
SAMPLE DEPTH
0 - <1 FEET
1 - 10 FEET
>10 FEET
ANALYTICAL GROUPS
PCBs
METALS
SVOCs
SAMPLE LOCATION
U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA
CEBs in Soil at CERFA Sites - Underground Storage Tank and Utility Poles
Figure No. 4-42
Project No. 03-1317B-045
File Name 99015\DWGS\E42PE27
Date 03-31-99


STATE PLANE GRID
N 1,038,475
E 503,675
0 100 200 400
SCALE: 1" = 200'
SS-US-004
SS-PO-026
SS-PO-032
SS-PO-036
SS-US-005
SS-US-006
8
E 502,475
N 1,037,100
NOTE:
1 Contaminant group not analyzed at this depth.
LEGEND:
BUILDING
SECONDARY ROAD
AREA BOUNDARY
STUDY AREA
SURFACE SOIL CONFIRMATION SAMPLE
SOIL BORING CONFIRMATION SAMPLE
ALABAMA STATE PLANE GRID (EAST)
SAMPLE DEPTH
0 - <1 FEET
1 - 10 FEET
>10 FEET
ANALYTICAL GROUPS
PCBs
METALS
SVOCs
SAMPLE LOCATION
U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA
CEBs in Soil at CERFA Sites - Underground Storage Tank and Utility Poles
Figure No. 4-41
Project No. 03-8178-045
File Name 99015\DWGS\E42PIE28
Date 03-31-99

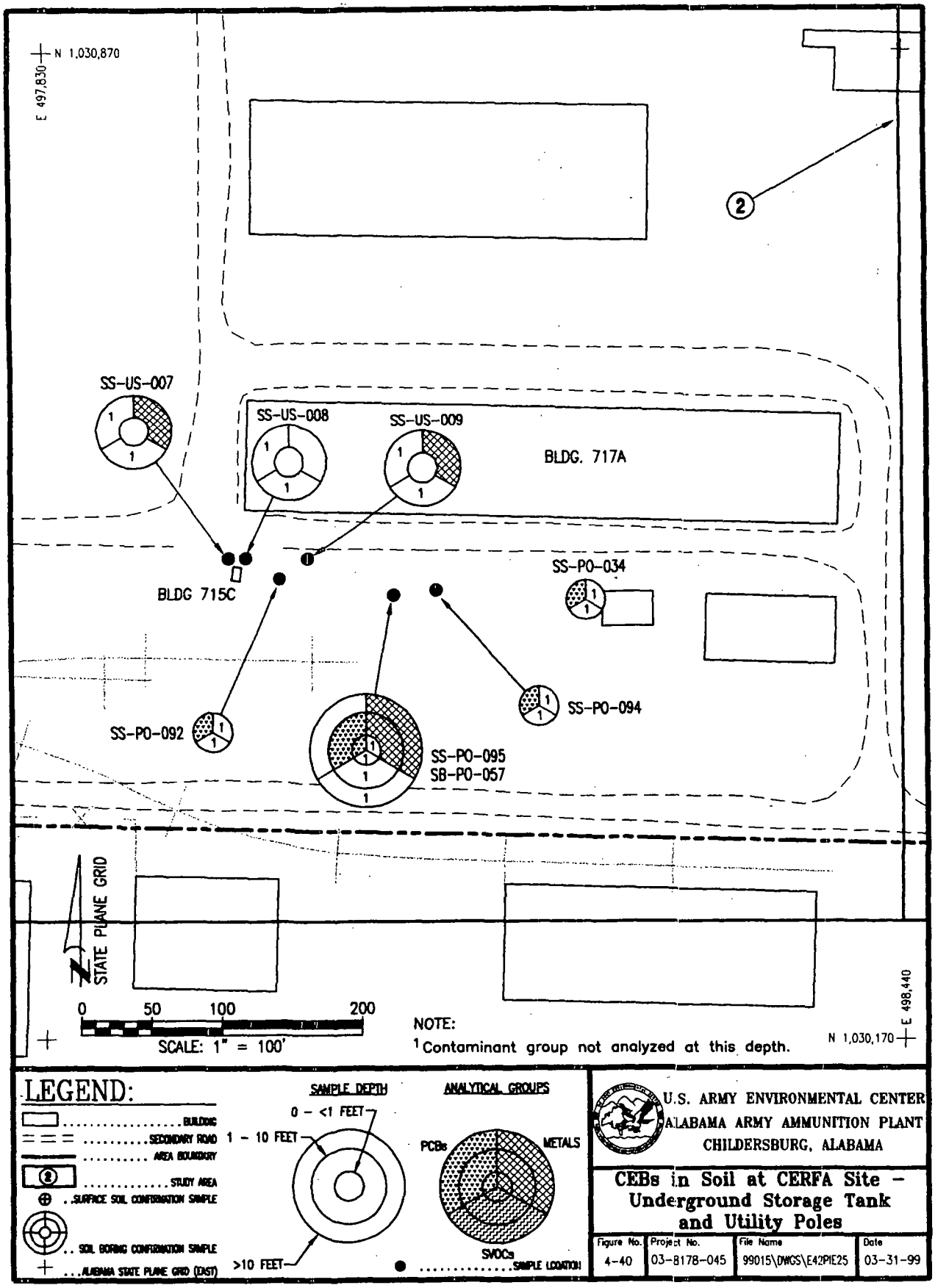

N 1,030,870
E 497,830
2
SS-US-007
SS-US-008
SS-US-009
BLDG. 717A
BLDG 715C
SS-PO-034
SS-PO-094
SS-PO-092
SS-PO-095
SB-PO-057
STATE PLANE GRID
0 50 100 200
SCALE: 1" = 100'
NOTE:
[1] Contaminant group not analyzed at this depth.
N 1,030,170
E 498,440
LEGEND:
BUILDING
SECONDARY ROAD
AREA BOUNDARY
STUDY AREA
SURFACE SOIL CONFIRMATION SAMPLE
SOIL BORING CONFIRMATION SAMPLE
ALABAMA STATE PLANE GRID (EAST)
SAMPLE DEPTH
0 - <1 FEET
1 - 10 FEET
>10 FEET
ANALYTICAL GROUPS
PCBs
METALS
SVOCs
SAMPLE LOCATION
U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA
CEBs in Soil at CERFA Site - Underground Storage Tank and Utility Poles
Figure No. 4-40
Project No. 03-8178-045
File Name 99015\DWGS\E42PIE25
Date 03-31-99

Table 4-68. Summary Statistics and Exposure Point Concentrations for Soil (>10 ft BLS) at Study Area PO - Downed Utility Poles with Transformers
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 7:23:34 PM
Run Date: 3/29/99
Exposure Unit: PO__SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	1 / 1	1 / 1	100%	--	--	25,000	25,000	--	--	Undetermined	--	25,000	#	27,567	[bk]
Arsenic	µg/g	1 / 1	1 / 1	100%	--	--	30	30	--	--	Undetermined	--	30	#	52	[bk]
Barium	µg/g	1 / 1	1 / 1	100%	--	--	166	166	--	--	Undetermined	--	166	#	41	[CEB]
Beryllium	µg/g	1 / 1	1 / 1	100%	--	--	3.9	3.9	--	--	Undetermined	--	3.9	#	0.89	[CEB]
Cadmium	µg/g	1 / 1	1 / 1	100%	--	--	0.94	0.94	--	--	Undetermined	--	0.94	#	--	[CEB]
Calcium	µg/g	1 / 1	1 / 1	100%	--	--	1,110	1,110	--	--	Undetermined	--	1,110	#	257	[CEB]
Chromium	µg/g	1 / 1	1 / 1	100%	--	--	29	29	--	--	Undetermined	--	29	#	53	[bk]
Copper	µg/g	1 / 1	1 / 1	100%	--	--	19	19	--	--	Undetermined	--	19	#	56	[bk]
Iron	µg/g	1 / 1	1 / 1	100%	--	--	50,000	50,000	--	--	Undetermined	--	50,000	#	57,000	[bk]
Lead	µg/g	1 / 1	1 / 1	100%	--	--	26	26	--	--	Undetermined	--	26	#	32	[bk]
Magnesium	µg/g	1 / 1	1 / 1	100%	--	--	1,090	1,090	--	--	Undetermined	--	1,090	#	867	[CEB]
Manganese	µg/g	1 / 1	1 / 1	100%	--	--	12,000	12,000	--	--	Undetermined	--	12,000	#	1,331	[CEB]
Nickel	µg/g	1 / 1	1 / 1	100%	--	--	38	38	--	--	Undetermined	--	38	#	46	[bk]
Potassium	µg/g	1 / 1	1 / 1	100%	--	--	618	618	--	--	Undetermined	--	618	#	1,206	[bk]
Vanadium	µg/g	1 / 1	1 / 1	100%	--	--	47	47	--	--	Undetermined	--	47	#	92	[bk]
Zinc	µg/g	1 / 1	1 / 1	100%	--	--	70	70	--	--	Undetermined	--	70	#	104	[bk]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-67. Summary Statistics and Exposure Point Concentrations for Soil (1-10 ft BLS) at Study Area PO - Downed Utility Poles with Transformers
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 7:23:34 PM
Run Date: 3/29/99
Exposure Unit: PO_SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	1 / 1	1 / 1	100%	--	--	28,000	28,000	--	--	Undetermined	--	28,000	#	27,733	[CEB]
Arsenic	µg/g	1 / 1	1 / 1	100%	--	--	26	26	--	--	Undetermined	--	26	#	42	[bk]
Barium	µg/g	1 / 1	1 / 1	100%	--	--	40	40	--	--	Undetermined	--	40	#	64	[bk]
Beryllium	µg/g	1 / 1	1 / 1	100%	--	--	0.39	0.39	--	--	Undetermined	--	0.39	#	0.80	[bk]
Calcium	µg/g	1 / 1	1 / 1	100%	--	--	968	968	--	--	Undetermined	--	968	#	2,475	[bk]
Chromium	µg/g	1 / 1	1 / 1	100%	--	--	196	196	--	--	Undetermined	--	196	#	46	[CEB]
Copper	µg/g	1 / 1	1 / 1	100%	--	--	38	38	--	--	Undetermined	--	38	#	26	[CEB]
Iron	µg/g	1 / 1	1 / 1	100%	--	--	31,000	31,000	--	--	Undetermined	--	31,000	#	52,000	[bk]
Lead	µg/g	1 / 1	1 / 1	100%	--	--	37	37	--	--	Undetermined	--	37	#	14	[CEB]
Magnesium	µg/g	1 / 1	1 / 1	100%	--	--	473	473	--	--	Undetermined	--	473	#	1,399	[bk]
Manganese	µg/g	1 / 1	1 / 1	100%	--	--	221	221	--	--	Undetermined	--	221	#	682	[bk]
Nickel	µg/g	1 / 1	1 / 1	100%	--	--	13	13	--	--	Undetermined	--	13	#	21	[bk]
Potassium	µg/g	1 / 1	1 / 1	100%	--	--	274	274	--	--	Undetermined	--	274	#	1,324	[bk]
Vanadium	µg/g	1 / 1	1 / 1	100%	--	--	74	74	--	--	Undetermined	--	74	#	96	[bk]
Zinc	µg/g	1 / 1	1 / 1	100%	--	--	126	126	--	--	Undetermined	--	126	#	71	[CEB]
Aroclor 1260	µg/g	1 / 1	1 / 1	100%	--	--	0.064	0.064	--	--	Undetermined	--	0.064	#	--	[CEB]

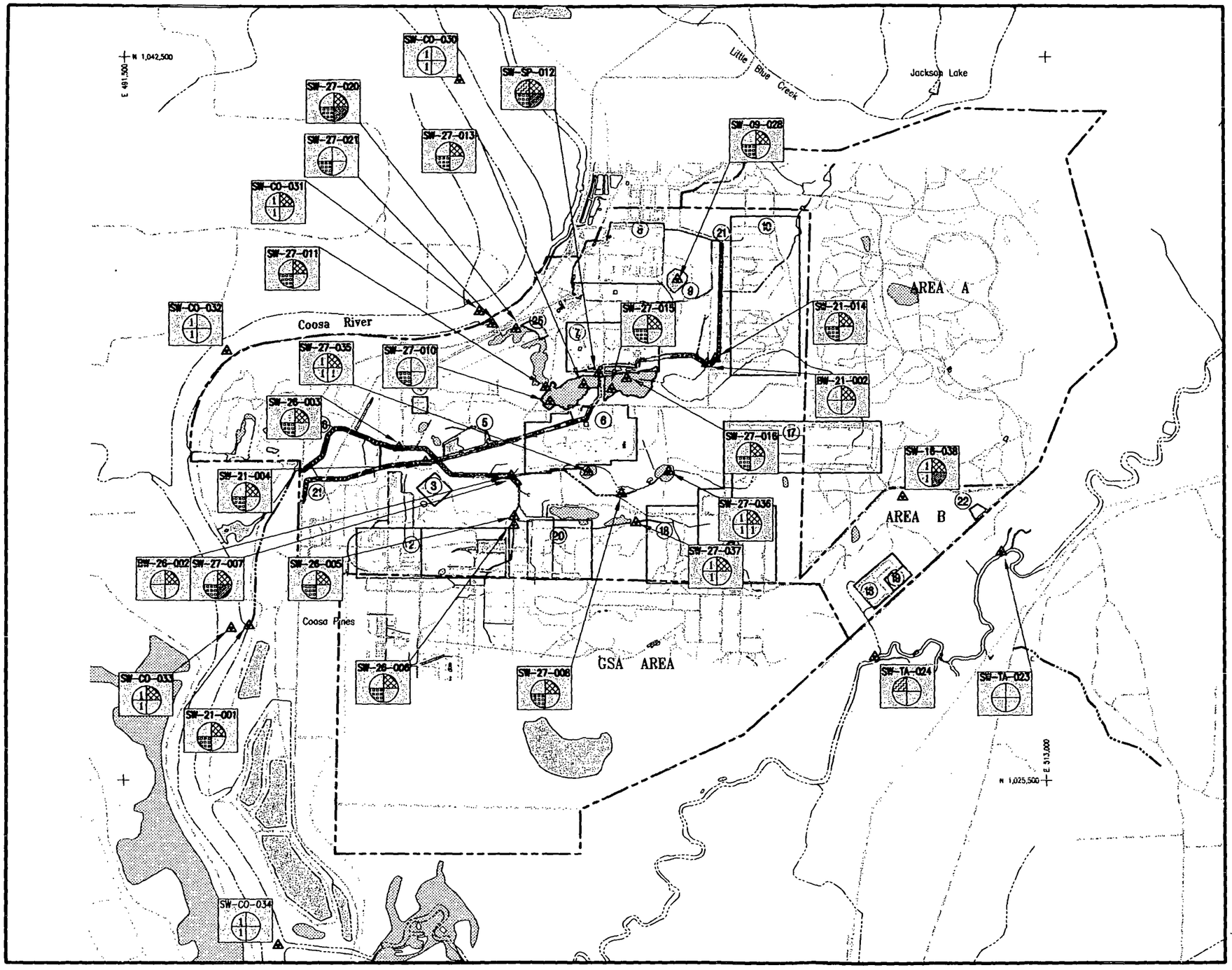
[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-66. Summary Statistics and Exposure Point Concentrations for Soil (0-<1 ft BLS) at Study Area PO - Downed Utility Poles with Transformers
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 7:23:34 PM
Run Date: 3/29/99
Exposure Unit: PO_SS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[g]	Background Comparison[g]
Aroclor 1248	µg/g	2 / 9	2 / 9	22%	0.033	1.7	40	69	12	25	Lognormal	9.29E+06	69	#	- -	[CEB]
Aroclor 1254	µg/g	2 / 9	2 / 9	22%	0.033	1.7	17	24	4.7	9.1	Lognormal	186,258	24	#	- -	[CEB]
Aroclor 1260	µg/g	8 / 9	8 / 9	89%	0.033	0.033	0.048	102	15	33	Lognormal	411,726	102	#	- -	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
- - Not applicable (note: background comparison not conducted for organic compounds)



LEGEND:

- BUILDINGS
- PRIMARY ROADS
- SECONDARY ROADS
- TRAILS
- FENCE
- AREA BOUNDARIES
- (7) STUDY AREAS
- RAIL ROAD
- CREEK, TRIBUTARIES AND RIVER
- WETLANDS
- PONDS, IMPOUNDMENTS
- SW-09-028 SURFACE WATER SAMPLE
- BW-21-002 SURFACE WATER SAMPLE COLLECTED FOR BIOASSAY
- GRID BASED ON ALABAMA STATE PLANE EAST
- SURFACE WATER CONFIRMATION SAMPLE

ANALYTICAL GROUPS
SVOCs METALS
VOCs EXPLOSIVES

NOTE:

1. CONTAMINANT GROUP NOT ANALYZED AT THIS LOCATION

0 625 1250 5000
SCALE: 1" = 2500'
STATE PLANE GRID

U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

CEBs in Surface Water at ALAAP

Figure No.	Project No.	File Name	Date
4-46	01-0827-03-8178-045	99015\DWGS\E42PIE30	03-31-99

Table 4-76. Summary Statistics and Exposure Point Concentrations for Surface Water at Study Area 9 - Aniline Sludge Basin
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:40:31 PM
Run Date: 3/29/99
Exposure Unit: 09_WS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Arsenic	µg/L	1 / 1	1 / 1	100%	--	--	1.2	1.2	--	--	Undetermined	--	1.2	#	1.4	[bk]
Barium	µg/L	1 / 1	1 / 1	100%	--	--	27	27	--	--	Undetermined	--	27	#	78	[bk]
Calcium	µg/L	1 / 1	1 / 1	100%	--	--	81,400	81,400	--	--	Undetermined	--	81,400	#	63,167	[CEB]
Copper	µg/L	1 / 1	1 / 1	100%	--	--	14	14	--	--	Undetermined	--	14	#	--	[CEB]
Iron	µg/L	1 / 1	1 / 1	100%	--	--	1,570	1,570	--	--	Undetermined	--	1,570	#	642	[CEB]
Lead	µg/L	1 / 1	1 / 1	100%	--	--	3.0	3.0	--	--	Undetermined	--	3.0	#	--	[CEB]
Magnesium	µg/L	1 / 1	1 / 1	100%	--	--	2,100	2,100	--	--	Undetermined	--	2,100	#	18,470	[bk]
Manganese	µg/L	1 / 1	1 / 1	100%	--	--	100	100	--	--	Undetermined	--	100	#	355	[bk]
Potassium	µg/L	1 / 1	1 / 1	100%	--	--	3,870	3,870	--	--	Undetermined	--	3,870	#	2,197	[CEB]
Sodium	µg/L	1 / 1	1 / 1	100%	--	--	2,790	2,790	--	--	Undetermined	--	2,790	#	8,555	[bk]
Toluene	µg/L	1 / 1	1 / 1	100%	--	--	0.60	0.60	--	--	Undetermined	--	0.60	#	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

SVOCs—SVOCs were not detected in the surface water sample collected at Study Area 9.

Summary—One surface water sample (SW-09-028) was collected from the Aniline Sludge Basin. A low concentration (near the CRL) of toluene and five metals (calcium, copper, iron, lead, and potassium) were the only chemical constituents that were detected above background in the ponded drainage in the Aniline Sludge Basin.

4.6.3 Study Area 16–Flashing Ground

During Phase 3 of the Supplemental RI, a surface water sample (SW-16-038) was analyzed from an area of ponded drainage associated with Study Area 16. The sample was analyzed for metals and explosives. **Table 4-77** presents the summary statistics for sample SW-16-038. Figure 4-46 shows the sampling location and general contaminant group CEBs that were detected.

Metals—Cobalt, iron, manganese, and nickel were the only inorganic constituents that were detected at concentrations above the background levels in sample SW-16-038. Manganese did not exceed background in Study Area 16 soil samples, although cobalt, iron, and nickel all were surface soil CEBs.

Maximum Concentrations**	
Analyte	µg/L
Cobalt	141
Iron	10,800
Manganese	1,200
Nickel	10.4

** ANOVA evaluation not conducted because there are fewer than four samples in the data set.

Explosives—The explosives compounds TNT and 2,4-DNT were detected in sample SW-16-038. TNT and 2,4-DNT also were detected in the shallow subsurface soils at Study Area 16 during the Supplemental RI.

Maximum Concentrations	
Analyte	µg/L
TNT	0.733
2,4-DNT	4.5

Summary—A surface water sample (SW-16-038) was analyzed from an area of ponded drainage associated with Study Area 16. TNT and 2,4-DNT were detected in the Study Area 16 drainage sample at concentrations less than 5 µg/L. Cobalt, iron, manganese, and nickel exceeded background concentrations; however, no other constituent metals were detected above background concentrations.

4.6.4 Study Area 21–Red Water Ditch

Surface water quality in Study Area 21, the Red Water Ditch, was characterized by the analysis of samples from four locations (BW-21-002, SW-21-001, SW-21-004, and SW-21-014) obtained during Phase 1 of the Supplemental RI. Samples were analyzed for metals, explosives, VOCs, and SVOCs. Figure 4-46 shows the general contaminant group CEBs that were detected at each location. **Table 4-78** presents the summary statistics for the detected constituents in surface water at Study Area 21.

Table 4-77. Summary Statistics and Exposure Point Concentrations for Surface Water at Study Area 16 - Flashing Ground
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:54:08 PM
Run Date: 3/29/99
Exposure Unit: 16_WS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/L	1 / 1	1 / 1	100%	--	--	154	154	--	--	Undetermined	--	154	#	309	[bk]
Barium	µg/L	1 / 1	1 / 1	100%	--	--	14	14	--	--	Undetermined	--	14	#	78	[bk]
Calcium	µg/L	1 / 1	1 / 1	100%	--	--	3,760	3,760	--	--	Undetermined	--	3,760	#	63,167	[bk]
Cobalt	µg/L	1 / 1	1 / 1	100%	--	--	141	141	--	--	Undetermined	--	141	#	--	[CEB]
Iron	µg/L	1 / 1	1 / 1	100%	--	--	10,800	10,800	--	--	Undetermined	--	10,800	#	642	[CEB]
Magnesium	µg/L	1 / 1	1 / 1	100%	--	--	1,360	1,360	--	--	Undetermined	--	1,360	#	18,470	[bk]
Manganese	µg/L	1 / 1	1 / 1	100%	--	--	1,200	1,200	--	--	Undetermined	--	1,200	#	355	[CEB]
Nickel	µg/L	1 / 1	1 / 1	100%	--	--	10	10	--	--	Undetermined	--	10	#	--	[CEB]
Potassium	µg/L	1 / 1	1 / 1	100%	--	--	1,140	1,140	--	--	Undetermined	--	1,140	#	2,197	[bk]
Sodium	µg/L	1 / 1	1 / 1	100%	--	--	5,090	5,090	--	--	Undetermined	--	5,090	#	8,555	[bk]
2,4,6-Trinitrotoluene	µg/L	1 / 1	1 / 1	100%	--	--	0.73	0.73	--	--	Undetermined	--	0.73	#	--	[CEB]
2,4-Dinitrotoluene	µg/L	1 / 1	1 / 1	100%	--	--	4.5	4.5	--	--	Undetermined	--	4.5	#	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.

[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).

[c] *CRL - contract reporting limit.*

[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).

[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.

[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.

[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.

-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-78. Summary Statistics and Exposure Point Concentrations for Surface Water at Study Area 21 - Red Water Ditch
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:13:18 PM
Run Date: 3/29/99
Exposure Unit: 21__WS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/L	4 / 4	4 / 4	100%	--	--	544	2,210	1,278	819	Normal	2,242	2,210	#	309	[CEB]
Antimony	µg/L	1 / 4	1 / 4	25%	1.00	1.00	2.0	2.0	0.87	0.73	Lognormal	5.7	2.0	#	2.7	[bk]
Arsenic	µg/L	3 / 4	3 / 4	75%	1.00	1.00	1.7	10.0	3.6	4.3	Normal	8.7	8.7		1.4	[CEB][ANOVA]
Barium	µg/L	5 / 5	4 / 4	100%	--	--	39	83	54	12	Normal	68	68		78	[CEB][ANOVA]
Calcium	µg/L	4 / 4	4 / 4	100%	--	--	7,050	23,000	15,395	8,177	Normal	25,017	23,000	#	63,167	[bk]
Iron	µg/L	5 / 5	4 / 4	100%	--	--	503	7,460	2,755	1,910	Normal	5,002	5,002		642	[CEB]
Lead	µg/L	2 / 4	2 / 4	50%	1.3	1.3	1.3	6.2	2.2	2.7	Lognormal	209	6.2	#	--	[CEB]
Magnesium	µg/L	4 / 4	4 / 4	100%	--	--	1,580	5,940	3,608	2,086	Normal	6,062	5,940	#	18,470	[bk]
Manganese	µg/L	5 / 5	4 / 4	100%	--	--	121	1,800	1,174	716	Normal	2,017	1,800	#	355	[CEB][ANOVA]
Potassium	µg/L	4 / 4	4 / 4	100%	--	--	1,570	7,150	3,565	2,564	Normal	6,582	6,582		2,197	[CEB]
Sodium	µg/L	4 / 4	4 / 4	100%	--	--	1,350	9,010	4,468	3,636	Normal	8,745	8,745		8,555	[CEB][ANOVA]
Zinc	µg/L	1 / 4	1 / 4	25%	21	21	23	23	14	6.4	Lognormal	29	23	#	--	[CEB]
Acetone	µg/L	1 / 4	1 / 4	25%	13	30	41	41	17	16	Normal	36	36		--	[CEB]
Carbon Disulfide	µg/L	1 / 4	1 / 4	25%	0.50	1.00	2.9	2.9	0.98	1.3	Lognormal	180	2.9	#	--	[CEB]
Chloroform	µg/L	1 / 4	1 / 4	25%	0.50	0.50	2.0	2.0	0.69	0.88	Lognormal	46	2.0	#	--	[CEB]
Toluene	µg/L	1 / 4	1 / 4	25%	0.50	0.50	1.00	1.00	0.44	0.38	Lognormal	3.0	1.00	#	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Metals—Nine metals exceeded background in the Study Area 21 surface water samples, as shown in the adjacent box. CEB concentrations of aluminum (544 to 2,210 µg/L) were detected in all of the Study Area 21 samples. The maximum concentrations for lead and zinc were detected in sample SW-21-014 located at the eastern end of the Red Water Ditch. The maximum observed concentrations of iron and potassium occurred in sample SW-21-004 located at the western end of the Red Water Ditch.

Maximum Concentrations*	
Analyte	**µg/L**
Aluminum	**2,210**
Arsenic	10
Barium	83.3
Iron	**7,460**
Lead	**6.18**
Manganese	1,800
Potassium	**7,150**
Sodium	9,010
Zinc	**23.4**

* Metals also determined to exceed background based on ANOVA evaluation are shown in bold.

Explosives—Explosives compounds were not detected in surface water samples collected at Study Area 21.

VOCs—Isolated concentrations of four VOCs (acetone, carbon disulfide, chloroform, and toluene) were detected in the surface water within the Red Water Ditch drainage in samples SW-21-001, SW-21-004, and SW-21-014. The maximum concentrations are shown in the adjacent box. Acetone was detected in SW-21-004, and carbon disulfide was detected in sample SW-21-001. Both chloroform and toluene were detected only in SW-21-014.

Maximum Concentrations	
Analyte	**µg/L**
Acetone	41
Carbon Disulfide	2.9
Chloroform	2
Toluene	1

SVOCs—SVOCs were not detected in surface water samples from Study Area 21.

Summary – Surface water quality in the Red Water Ditch was characterized by the analysis of samples from four locations. Nine metals that exceed background were detected in upstream and downstream samples. Isolated concentrations of four VOCs were variably detected in surface water samples from the Red Water Ditch. Explosives compounds were not detected in the ditch drainage.

4.6.5 Study Area 26–Crossover Ditch

During Phases 1 and 2 of the Supplemental RI, surface water samples were obtained from nine locations (BW-26-002, SW-26-003, SW-26-005, SW-26-006, SW-27-007, SW-27-008, SW-27-035, SW-27-036, and SW-27-037) along the Crossover Ditch alignment in the western portion of the installation. Samples were analyzed for metals, explosives, VOCs, and SVOCs. **Table 4-79** presents the summary statistics for the detected constituents at Study Area 26. Figure 4-46 shows the general contaminant group CEBs that were detected.

Table 4-79. Summary Statistics and Exposure Point Concentrations for Surface Water at Study Area 26 - Crossover Ditch
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:28:25 PM
Run Date: 3/29/99
Exposure Unit: 26__WS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/L	8 / 9	8 / 9	89%	141	141	161	1,710	463	522	Lognormal	1,285	1,285		309	[CEB][ANOVA]
Arsenic	µg/L	9 / 9	9 / 9	100%	--	--	2.4	7.5	4.3	1.9	Normal	5.5	5.5		1.4	[CEB]
Barium	µg/L	10 / 10	9 / 9	100%	--	--	15	132	52	26	Normal	68	68		78	[CEB][ANOVA]
Calcium	µg/L	9 / 9	9 / 9	100%	--	--	6,950	34,700	21,550	10,411	Normal	28,003	28,003		63,167	[bk]
Iron	µg/L	10 / 10	9 / 9	100%	--	--	1,030	8,370	3,487	2,455	Normal	5,008	5,008		642	[CEB]
Lead	µg/L	4 / 9	4 / 9	44%	1.00	1.3	1.1	2.3	1.1	0.67	Lognormal	1.8	1.8		--	[CEB]
Magnesium	µg/L	9 / 9	9 / 9	100%	--	--	1,350	10,600	5,761	3,349	Normal	7,837	7,837		18,470	[bk]
Manganese	µg/L	10 / 10	9 / 9	100%	--	--	192	7,240	1,150	1,313	Lognormal	3,471	3,471		355	[CEB]
Potassium	µg/L	9 / 9	9 / 9	100%	--	--	1,560	3,510	2,398	612	Normal	2,777	2,777		2,197	[CEB]
Sodium	µg/L	7 / 9	7 / 9	78%	2,290	2,290	1,340	4,950	2,829	1,454	Normal	3,730	3,730		8,555	[bk]
2,4-Dinitrotoluene	µg/L	1 / 7	1 / 7	14%	0.064	0.064	0.17	0.17	0.051	0.052	Lognormal	0.100	0.100		--	[CEB]
Carbon Disulfide	µg/L	1 / 6	1 / 6	17%	0.50	0.50	2.7	2.7	0.66	1.0	Lognormal	3.4	2.7	#	--	[CEB]
Carbon Tetrachloride	µg/L	1 / 6	1 / 6	17%	0.58	0.58	0.74	0.74	0.37	0.18	Lognormal	0.55	0.55		--	[CEB]
Chloroform	µg/L	2 / 6	2 / 6	33%	0.50	0.50	0.71	1.5	0.54	0.51	Lognormal	1.7	1.5	#	--	[CEB]
Methylene Chloride	µg/L	5 / 6	5 / 6	83%	2.8	2.8	2.5	3.4	2.5	0.64	Normal	3.1	3.1		--	[CEB]
Toluene	µg/L	1 / 6	1 / 6	17%	0.50	0.50	1.1	1.1	0.39	0.35	Lognormal	0.84	0.84		--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Metals—Seven metals were detected above background concentrations in the Study Area 26 surface water samples. Arsenic concentrations exceeding background were distributed over the length of the Crossover Ditch drainage, with the maximum concentration detected in sample SW-27-037 located west of Study Area 18. Manganese (192 to 7,240 µg/g) exceeded background in samples from all locations except two (SW-26-005 and SW-27-007). Lead (1.11 to 2.27 µg/g) was a CEB at all four locations along the length of the ditch (SW-26-003, SW-27-008, SW-27-035, and SW-27-037) where it was detected. Iron (1,030 to 8,370 µg/L) and potassium (1,560 to 3,510 µg/L) were detected above background concentrations in the Crossover Ditch drainage.

Maximum Concentrations*	
Analyte	**µg/L**
Aluminum	1,710
Arsenic	**7.52**
Barium	132
Iron	**8,370**
Lead	**2.27**
Manganese	**7,240**
Potassium	**3,510**

* Metals also determined to exceed background based on ANOVA evaluation are shown in bold.

Explosives—An isolated concentration of 2,4-DNT (0.169 µg/L) was detected in one surface water sample (SW-27-007) located at the confluence of creek tributaries flowing north to the Crossover Ditch from Study Area 20 and west from Study Area 17.

VOCs—Five VOCs were detected in the Study Area 26 surface water samples. Carbon disulfide, carbon tetrachloride, and toluene were detected in surface water samples SW-26-006, SW-26-007, and SW-27-005, respectively. The samples were taken from within a portion of the Crossover Ditch that is immediately north of Study Area 20. Chloroform was detected in two of these samples (SW-26-006 and SW-27-007) north of Study Area 20. Methylene chloride (2.5 to 3.4 µg/L) was detected in five of the samples (SW-26-003, SW-26-005, SW-26-006, SW-27-007, and SW-27-008) that were located along the ditch drainage between Study Areas 3 and 18.

Maximum Concentrations	
Analyte	**µg/L**
Carbon Disulfide	2.7
Carbon Tetrachloride	0.74
Chloroform	1.5
Methylene Chloride	3.4
Toluene	1.1

SVOCs—SVOCs were not detected in the surface water sampled from the Crossover Ditch.

Summary—Aluminum, arsenic, barium, iron, lead, manganese, and potassium were detected in the surface water samples above the background concentrations. Arsenic, iron, lead, manganese, and potassium concentrations exceeding background were distributed over the length of the Crossover Ditch. Surface water samples were obtained from nine locations along the Crossover Ditch alignment in the western portion of the installation. Isolated concentrations of carbon disulfide, carbon tetrachloride, chloroform, and toluene were detected in surface water samples SW-26-005, SW-26-006, and SW-27-007 located within a portion of the Crossover Ditch that is located immediately north of Study Area 20. Methylene chloride was detected in five of the samples. SVOCs were not detected in the surface water samples. An isolated concentration of 2,4-DNT was detected in surface water at sample location SW-27-007.

4.6.6 Study Area 27–Beaver Pond Drainage System

Surface water quality in the drainage and ponds associated with the east and west Beaver Ponds was characterized by the analysis of samples obtained from eight locations (SW-27-010, SW-27-011, SW-27-013, SW-27-015, SW-27-016, SW-27-020, SW-27-021, and SW-SP-012), including locations within the ponds, at a seep located between the east and west Beaver Ponds, at the pond periphery, and at downgradient areas of ponded drainage. Samples were analyzed for metals, explosives, VOCs, and SVOCs. Figure 4-46 shows the general contaminant group CEBs that were detected at each location. **Table 4-80** presents the summary statistics for the detected constituents in surface water at Study Area 27.

Metals—Seven metals exceeded background in the Study Area 27 surface water samples, as shown in the adjacent box. CEB concentrations of aluminum, barium, lead, and zinc were solely detected in the seep discharge at sample location SW-SP-012. The maximum concentrations of arsenic, manganese, and iron also were detected in sample SW-SP-012.

Maximum Concentrations*	
Analyte	µg/L
Aluminum	3,660
Arsenic	3.12
Barium	79.7
Iron	8,420
Lead	**16.5**
Manganese	**6,300**
Zinc	**22.4**

* Metals also determined to exceed background based on ANOVA evaluation are shown in bold.

Explosives—Eight explosives were detected in the Study Area 27 surface water samples (see adjacent box). Explosives compounds were detected predominantly in the seep sample (SW-SP-012) located between the east and west Beaver Ponds. TNT (10.5 µg/L), 2,4-DNT (0.104 to 3.18 µg/L), 2,6-DNT (0.291 to 0.323 µg/L), nitrobenzene (7.32 to 13.8 µg/L), o-nitrotoluene (3.46 to 5.75 µg/L), p-nitrotoluene (3.12 to 5.59 µg/L), and the explosives breakdown products 2-A-4,6-DNT (0.965 to 6.02 µg/L) and 4-A-2,6-DNT (6.96 µg/L) were detected in the seep discharge. 2,4-DNT (0.104 µg/L) also was detected in surface water sample SW-27-020 near the Coosa River.

Maximum Concentrations	
Analyte	µg/L
2,4-DNT	3.18
2,6-DNT	0.323
2-A-4,6-DNT	6.02
4-A-2,6-DNT	6.96
Nitrobenzene	13.8
o-Nitrotoluene	5.75
p-Nitrotoluene	5.59
TNT	10.5

VOCs—Three VOCs were detected in the Study Area 27 surface water samples, as shown in the adjacent box. Isolated concentrations of acetone (23 µg/L) and carbon disulfide (1.7 µg/L) were detected in samples SW-27-010 and SW-SP-012, respectively. Concentrations of toluene (0.54 to 2.2 µg/L) were broadly distributed in the samples.

Maximum Concentrations	
Analyte	µg/L
Acetone	23
Carbon Disulfide	1.7
Toluene	2.2

SVOCs—B2EHP (5.8 µg/L) was detected in the surface seep sample (SW-SP-012). No other SVOCs were detected.

Table 4-80. Summary Statistics and Exposure Point Concentrations for Surface Water at Study Area 27 - Beaver Pond Drainage System
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:36:44 PM
Run Date: 3/29/99
Exposure Unit: 27_WS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/L	3 / 9	2 / 8	25%	141	141	35	3,660	304	624	Lognormal	1,191	1,191		309	[CEB][ANOVA]
Antimony	µg/L	1 / 9	1 / 8	13%	1.00	1.00	1.1	1.1	0.54	0.11	Lognormal	0.61	0.61		2.7	[bk]
Arsenic	µg/L	4 / 9	3 / 8	38%	1.00	1.00	1.1	3.1	0.91	0.66	Lognormal	1.7	1.7		1.4	[CEB][ANOVA]
Barium	µg/L	9 / 9	8 / 8	100%	--	--	20	80	46	23	Normal	61	61		78	[CEB][ANOVA]
Calcium	µg/L	9 / 9	8 / 8	100%	--	--	9,480	54,300	21,929	11,171	Normal	29,412	29,412		63,167	[bk]
Iron	µg/L	9 / 9	8 / 8	100%	--	--	293	8,420	1,656	2,347	Lognormal	6,082	6,082		642	[CEB][ANOVA]
Lead	µg/L	1 / 9	1 / 8	13%	1.00	1.3	17	17	1.6	2.8	Lognormal	4.1	4.1		--	[CEB]
Magnesium	µg/L	9 / 9	8 / 8	100%	--	--	2,260	9,100	5,614	2,058	Normal	6,992	6,992		18,470	[bk]
Manganese	µg/L	9 / 9	8 / 8	100%	--	--	138	6,300	1,308	1,718	Lognormal	7,444	6,300	#	355	[CEB]
Potassium	µg/L	7 / 9	7 / 8	88%	375	1000	1,010	1,960	1,206	552	Normal	1,576	1,576		2,197	[bk]
Sodium	µg/L	9 / 9	8 / 8	100%	--	--	1,150	4,860	2,158	1,215	Lognormal	3,240	3,240		8,555	[bk]
Zinc	µg/L	1 / 9	1 / 8	13%	21	36	22	22	12	3.4	Lognormal	14	14		--	[CEB]
2,4,6-Trinitrotoluene	µg/L	1 / 9	1 / 8	13%	0.64	0.64	11	11	0.95	1.8	Lognormal	2.7	2.7		--	[CEB]
2,4-Dinitrotoluene	µg/L	3 / 9	2 / 8	25%	0.064	0.064	0.10	3.2	0.38	0.96	Lognormal	4.2	3.2	#	--	[CEB]
2,6-Dinitrotoluene	µg/L	2 / 9	1 / 8	13%	0.074	0.074	0.29	0.32	0.071	0.095	Lognormal	0.14	0.14		--	[CEB]
2-Amino-4,6-Dinitrotoluene	µg/L	2 / 9	1 / 8	13%	0.16	0.16	0.97	6.0	0.51	1.2	Lognormal	2.8	2.8		--	[CEB]
4-Amino-2,6-Dinitrotoluene	µg/L	1 / 9	1 / 8	13%	1.6	1.6	7.0	7.0	1.2	1.1	Lognormal	1.9	1.9		--	[CEB]
Acetone	µg/L	1 / 8	1 / 8	13%	13	29	23	23	11	5.8	Lognormal	16	16		--	[CEB]
Carbon Disulfide	µg/L	1 / 8	1 / 8	13%	0.50	0.50	1.7	1.7	0.43	0.51	Lognormal	0.80	0.80		--	[CEB]
Nitrobenzene	µg/L	2 / 9	1 / 8	13%	0.65	0.65	7.3	14	1.6	3.6	Lognormal	7.0	7.0		--	[CEB]
Toluene	µg/L	8 / 8	8 / 8	100%	--	--	0.54	2.2	1.1	0.68	Lognormal	1.9	1.9		--	[CEB]
bis(2-Ethylhexyl)phthalate	µg/L	1 / 8	1 / 8	13%	4.8	9.1	5.8	5.8	3.1	1.3	Lognormal	4.1	4.1		--	[CEB]
o-Nitrotoluene	µg/L	2 / 9	1 / 8	13%	0.41	0.41	3.5	5.8	0.75	1.6	Lognormal	2.6	2.6		--	[CEB]
p-Nitrotoluene	µg/L	2 / 9	1 / 8	13%	1.1	1.1	3.1	5.6	1.0	1.3	Lognormal	2.0	2.0		--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) *If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution.* 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (*chemical exceeding background*) - *the maximum detected result is greater than or equal to two times the background mean;* bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Summary—Surface water quality in the drainage and ponds associated with the east and west Beaver Ponds was characterized by the analysis of samples obtained from within the ponds, at a seep located between the east and west Beaver Ponds, at the pond periphery, and at downgradient areas of ponded drainage. Aluminum, arsenic, barium, iron, lead, manganese, and zinc were detected at concentrations exceeding background in the Beaver Pond Drainage System. Sample SW-SP-012 from the seep discharge contained the highest concentrations of metals. Isolated concentrations of acetone and carbon disulfide were detected in samples SW-27-010 and SW-SP-012. Concentrations of toluene were broadly distributed in the Beaver Pond Drainage System samples. B2EHP was detected only in the seep sample. Explosives compounds were detected predominantly in the seep sample. TNT, 2,4-DNT, 2,6-DNT, nitrobenzene, o-nitrotoluene, p-nitrotoluene, and the explosives breakdown products 2-A-4,6-DNT and 4-A-2,6-DNT were detected in the seep discharge. 2,4-DNT also was detected in surface water sample SW-27-020 near the Coosa River.

4.6.7 Talladega Creek

Surface water quality in Talladega Creek was assessed by analyzing samples obtained from two locations (SW-TA-023 and SW-TA-024) along the creek south of ALAAP. Samples were analyzed for VOCs, SVOCs, pesticides, metals, and explosives. Figure 4-46 shows the general contaminant group CEBs that were detected at each location. **Table 4-81** presents the summary statistics for the detected constituents in the Talladega Creek surface water.

Metals—Metals concentrations in surface water samples from Talladega Creek did not exceed background.

Explosives—Explosives were not detected in the surface water samples collected from Talladega Creek.

VOCs—VOCs were not detected in the surface water samples from Talladega Creek.

SVOCs—Diethyl phthalate (3.4 μg/L) was detected in surface water sample SW-TA-024.

Pesticides—Pesticides were not detected in the surface water samples collected from Talladega Creek.

Summary —Surface water quality in Talladega Creek was assessed by analyzing samples obtained from two locations along the creek south of ALAAP. Metals concentrations in surface water samples from Talladega Creek did not exceed background at the sampled locations. VOCs, pesticides, and explosives were not detected in the surface water samples from Talladega Creek. An isolated concentration of diethyl phthalate was detected in surface water sample SW-TA-024.

Table 4-81. Summary Statistics and Exposure Point Concentrations for Surface Water at Study Area TA - Talladega Creek
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 7:31:39 PM
Run Date: 3/29/99
Exposure Unit: TA_WS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/L	1 / 2	1 / 2	50%	141	141	181	181	--	--	Undetermined	--	181	#	309	[bk]
Barium	µg/L	2 / 2	2 / 2	100%	--	--	21	21	--	--	Undetermined	--	21	#	78	[bk]
Calcium	µg/L	2 / 2	2 / 2	100%	--	--	26,700	26,900	--	--	Undetermined	--	26,900	#	63,167	[bk]
Iron	µg/L	2 / 2	2 / 2	100%	--	--	230	255	--	--	Undetermined	--	255	#	642	[bk]
Magnesium	µg/L	2 / 2	2 / 2	100%	--	--	13,700	13,800	--	--	Undetermined	--	13,800	#	18,470	[bk]
Manganese	µg/L	2 / 2	2 / 2	100%	--	--	57	57	--	--	Undetermined	--	57	#	355	[bk]
Potassium	µg/L	2 / 2	2 / 2	100%	--	--	1,360	1,560	--	--	Undetermined	--	1,560	#	2,197	[bk]
Sodium	µg/L	2 / 2	2 / 2	100%	--	--	5,230	5,890	--	--	Undetermined	--	5,890	#	8,555	[bk]
Diethyl Phthalate	µg/L	1 / 2	1 / 2	50%	2.0	2.0	3.4	3.4	--	--	Undetermined	--	3.4	#	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] *Distributions for the calculation of exposure point concentrations* (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance *determines that the site and background data sets come from the same population.*
-- Not applicable (note: background comparison not conducted for organic compounds)

4.6.8 Coosa River

Surface water quality in the Coosa River was assessed by analyzing samples obtained from five locations (SW-CO-030 to SW-CO-034) along the river adjacent to ALAAP. Figure 4-46 shows the general contaminant group CEBs that were detected at each location. Samples were analyzed for metals and explosives. **Table 4-82** presents the summary statistics for the detected constituents in the Coosa River surface water.

Metals—Aluminum (189 to 603 µg/L), arsenic (1.17 to 1.42 µg/L), and iron (227 to 782 µg/L) were detected at concentrations exceeding background in the Coosa River. The elevated metals concentrations were detected in samples SW-CO-031 and SW-CO-033.

Maximum Concentrations*	
Analyte	µg/L
Aluminum	603
Arsenic	1.42
Iron	782

* ANOVA evaluation determined that none of these metals exceeds background.

Explosives—Explosives were not detected in the surface water samples collected from the Coosa River.

Summary—Surface water quality in the Coosa River was assessed by analyzing samples obtained from five locations along the river adjacent to ALAAP. Aluminum, arsenic, and iron exceeded background. Explosives compounds were not detected in the surface water samples collected from the Coosa River.

4.6.9 Surface Water Quality Summary

Surface water was sampled from drainage areas (Red Water Ditch, Crossover Ditch, and the Beaver Pond Drainage System), Talladega Creek, and the Coosa River to determine if previous activities at Area B of ALAAP have impacted the water quality. In addition, limited sampling was conducted in the Aniline Sludge Basin and an area of ponded drainage associated with the Flashing Ground. Comparisons of chemical data were made to background surface water sampled from selected locations at Talladega Creek and Fanning Creek.

The chemicals that were detected in the background samples and at concentrations exceeding background in the study area, Talladega Creek, and Coosa River surface water samples are shown in **Table 4-83**. CEB metals were detected at all sampled surface water study areas, Talladega Creek, and the Coosa River. Aluminum, arsenic, iron, lead, and manganese were the most frequently detected CEB metals.

CEB metals were detected at all locations along the Red Water and Crossover Ditches. CEB metals concentrations in study area samples were highest in the sample collected from the seep discharge between the east and west Beaver Ponds. Metals exceeded background at two of the Coosa River sampling locations. Metals did not exceed background in the two Talladega Creek samples.

Table 4-82. Summary Statistics and Exposure Point Concentrations for Surface Water at Study Area CO - Coosa River
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:56:23 PM
Run Date: 3/29/99
Exposure Unit: CO__WS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]	2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/L	5 / 5	5 / 5	100%	--	--	189	603	313	178	Normal	483	483	309	[CEB][ANOVA]
Arsenic	µg/L	5 / 5	5 / 5	100%	--	--	1.2	1.4	1.3	0.090	Normal	1.4	1.4	1.4	[CEB][ANOVA]
Barium	µg/L	5 / 5	5 / 5	100%	--	--	41	53	46	4.5	Normal	50	50	78	[bk]
Calcium	µg/L	5 / 5	5 / 5	100%	--	--	15,800	16,900	16,260	404	Normal	16,645	16,645	63,167	[bk]
Iron	µg/L	5 / 5	5 / 5	100%	--	--	227	782	398	238	Normal	625	625	642	[CEB][ANOVA]
Magnesium	µg/L	5 / 5	5 / 5	100%	--	--	4,390	5,370	4,658	403	Lognormal	5,178	5,178	18,470	[bk]
Manganese	µg/L	5 / 5	5 / 5	100%	--	--	103	295	179	77	Normal	252	252	355	[bk]
Potassium	µg/L	5 / 5	5 / 5	100%	--	--	1,300	1,790	1,472	196	Normal	1,659	1,659	2,197	[bk]
Sodium	µg/L	5 / 5	5 / 5	100%	--	--	5,680	5,920	5,806	94	Normal	5,895	5,895	8,555	[bk]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.

[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).

[c] CRL - contract reporting limit.

[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).

[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.

[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.

[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.

-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-83. Chemicals Exceeding Background in Surface Water Alabama Army Ammunition Plant, Childersburg, Alabama

Chemicals[a]	Study Areas					Talladega	Coosa	Background[b]
	9	16	21	26	27			
Inorganics								
Aluminum			1	1	1		1	1
Antimony								1
Arsenic			1	1	1		1	1
Barium			1	1	1			1
Calcium	1							1
Chromium								
Cobalt		1						
Copper	1							
Iron	1	1	1	1	1		1	1
Lead	1		1	1	1			
Magnesium								1
Manganese		1	1	1	1			1
Nickel		1						
Potassium	1		1	1				1
Selenium								1
Sodium			1					1
Zinc			1		1			
Explosives								
TNT		1			1			
2,4,-DNT		1		1	1			
2,6-DNT					1			
2-A-4,6-DNT					1			
4-A-2,6-DNT					1			
Nitrobenzene					1			
o-Nitrotoluene					1			
p-Nitrotoluene					1			
VOCs								
Acetone			1		1			1
Benzene								
Carbon Disulfide			1	1	1			
Carbon Tetrachloride				1				
Chloroform			1	1				
MEK								
Methyl Chloride				1				1
Toluene	1		1	1	1			1
SVOCs								
B2EHP					1			
Diethyl Phthalate						1		

[a] A value of 1 indicates that the chemical exceeded background in surface water.
[b] Metals and VOCs that were present in background surface water.

nitroaromatic compounds (such as TNT) in sediment samples ranged between 3.3 and 1,800 µg/g with an average concentration of 5.6 µg/g. Appendix C provides the detailed screening results of the transect sediment sampling for Study Areas 5, 9, 21, 26, and 27 (including the east and west Beaver Ponds and the Drainage System), Talladega Creek, and the Coosa River. Fanning Creek and Little Blue Creek were sampled, but no results were greater than the detection limit of 2.5 µg/g.

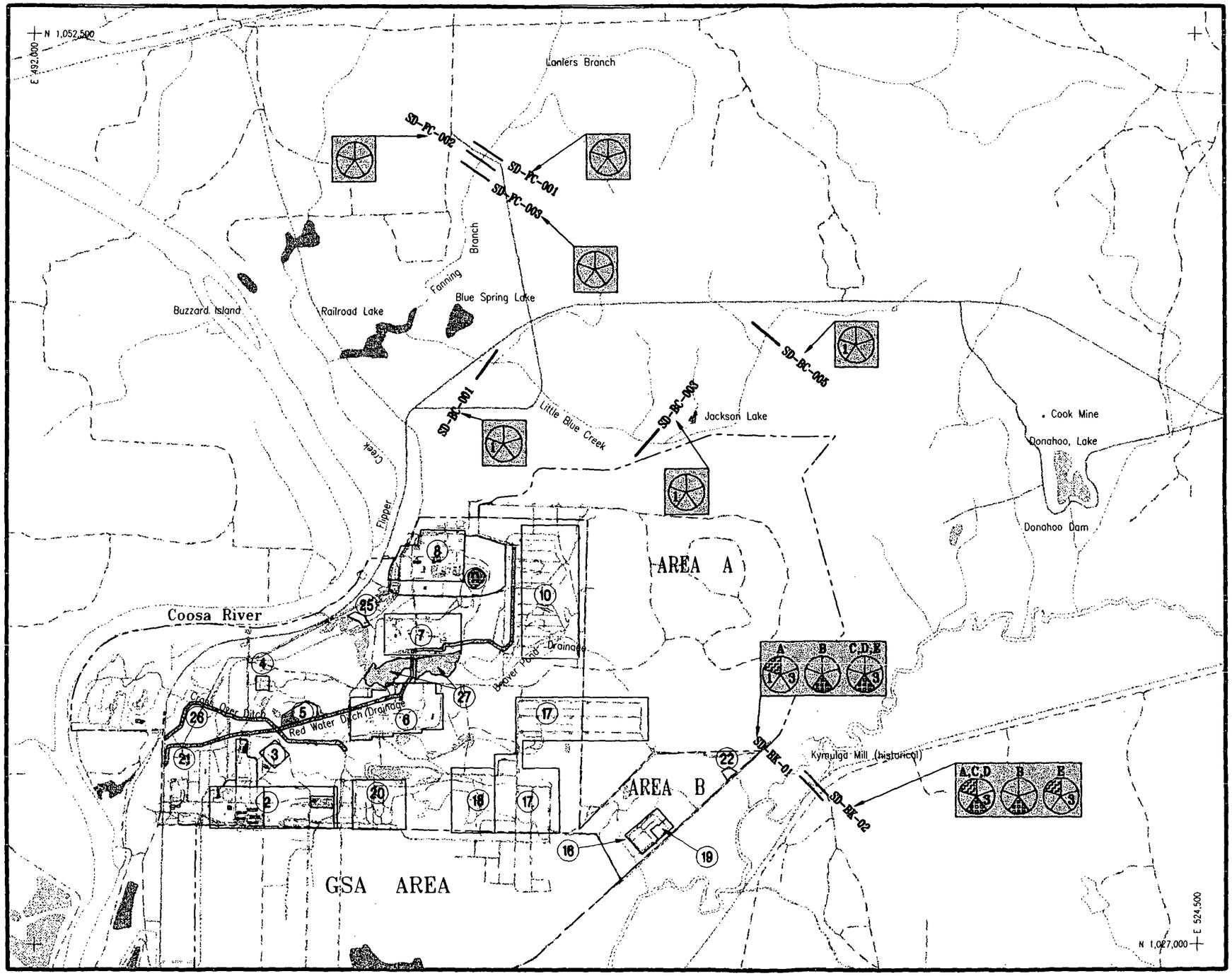
Sediment results exceeding a screening concentration of 30 µg/g were detected in isolated samples from Study Areas 9 (SD-09-1040), 21 (SD-21-1040), and 27 (SD-27-150D), and were generally very localized in extent (see Sheet 3-2 for sample locations). Results of the Phase 2 sample screening analysis for SD-21-500 were as follows: 4.4 µg/g of DNT and 7.4 µg/g of TNT. The presence of additional nitroaromatic compounds was indicated by color changes observed during the screening analyses. Colorimetric reactions indicative of 2,4-DNT were observed in four samples from Study Area 26 at nondetect (<2.5 µg/g) concentrations. Indicator reactions for tetryl were detected in 56 sediment samples from Study Areas 5 (<2.5 µg/g), 9 (<2.5 to 1,800 µg/g), 21 (<2.5 to 120 µg/g), 26 (<2.5 to 12.7 µg/g), 27 (<2.5 to 9.3 µg/g) and from tributaries to Talladega Creek (<2.5 to 8.4 µg/g), and from the Coosa River (<2.5 µg/g). Concentrations (11.9 to 22.1 µg/g) of DNT (as 2,6-DNT) were indicated in two samples (SD-26-540E and SD-26-550E) from Study Area 26. Confirmation of contaminant concentrations was obtained from fixed laboratory analysis performed on approximately 10 percent of the field-screened samples, and is discussed in the following subsections.

4.7.2 Background Sediment Results

Sediment samples were collected from two locations to serve as a background comparison: Fanning Creek (3 samples) and Talladega Creek (10 samples—5 each from 2 transects). Samples were analyzed for metals, explosives, VOCs, SVOCs, and pesticides/PCBs. A review of sediment data collected from Little Blue Creek indicated that the samples were characteristic of background conditions; therefore, these data also were used as part of the background data set. These samples were analyzed for metals, explosives, VOCs, and SVOCs. **Figure 4-47** shows the locations of the background sediment samples and analyte groups detected in these samples. **Table 4-85** provides the summary statistics for all analytes detected in the background sediment samples.

Metals—Seventeen metals were detected in the background sediment samples including aluminum, arsenic, barium, beryllium, chromium, cobalt, copper, iron, lead, manganese, nickel, vanadium, zinc, and the essential nutrient metals calcium, magnesium, potassium, and sodium. The maximum metals concentrations were detected at locations SD-BK-01E, SD-BC-003, SD-BK-01B, SD-BC-001, SD-BK-02B, SD-BK-02C, SD-BK-02D, and SD-FC-003.

Explosives—Nine sediment samples were collected and screened for explosives from Fanning Creek (three samples) and Little Blue Creek (six samples). Explosives compounds were not detected in any of the screening or confirmatory sediment samples collected from the background sediment locations.



LEGEND:

- BUILDINGS
- PRIMARY ROADS
- SECONDARY ROADS
- TRAILS
- FENCE
- AREA BOUNDARIES
- (27) STUDY AREAS
- RAIL ROAD
- CREEK, TRIBUTARIES AND RIVER
- WETLANDS
- PONDS, IMPOUNDMENTS
- GRID BASED ON ALABAMA STATE PLANE EAST
- A B C D E — SEDIMENT SAMPLE TRANSECTS (TYPICAL) STREAM FLOW UP RIVER
- SEDIMENT CONFIRMATION SAMPLE

ANALYTICAL GROUPS: SVOCs, METALS, PESTICIDES/PCBs, EXPLOSIVES, VOCs

NOTE:

1. CONTAMINANT GROUP NOT ANALYZED AT THIS LOCATION
2. METALS WERE DETECTED IN BACKGROUND SEDIMENT SAMPLES, BUT ARE NOT SHOWN HERE BECAUSE THEY ARE BACKGROUND.
3. EXPLOSIVES ANALYSIS FOR 2,4-DNT, 2,6-DNT & NB ONLY

0 1000 2000 3000 6000

SCALE: 1" = 3000'

STATE PLANE GRID

U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

Background Sediment Results

Figure No.	Project No.	File Name	Date
4-47	01-0827-03-8178-045	99015\DWGS\E42SEDBK	03-31-99

Table 4-85. Summary Statistics and Exposure Point Concentrations for Sediment at Study Area BK - Background
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 12:13:06 PM
Run Date: 3/31/99
Exposure Unit: BK__DS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	18 / 18	16 / 16	100%	--	--	2,450	28,000	12,661	7,594	Normal	15,990	15,990		25,323	--
Arsenic	µg/g	3 / 18	2 / 16	13%	13	13	5.4	20	7.4	3.4	Lognormal	8.4	8.4		15	--
Barium	µg/g	16 / 16	16 / 16	100%	--	--	19	151	75	44	Normal	95	95		151	--
Beryllium	µg/g	14 / 16	14 / 16	88%	0.25	0.25	0.39	1.6	0.77	0.39	Normal	0.94	0.94		1.5	--
Calcium	µg/g	16 / 16	16 / 16	100%	--	--	304	2,060	1,075	630	Normal	1,351	1,351		2,150	--
Chromium	µg/g	13 / 16	13 / 16	81%	21	43	12	41	23	7.9	Normal	26	26		46	--
Cobalt	µg/g	14 / 16	14 / 16	88%	2.5	2.5	4.8	17	9.4	5.1	Normal	12	12		19	--
Copper	µg/g	14 / 16	14 / 16	88%	3.4	3.4	4.6	62	21	17	Normal	28	28		42	--
Iron	µg/g	18 / 18	16 / 16	100%	--	--	6,900	60,000	23,130	12,834	Lognormal	31,540	31,540		46,260	--
Lead	µg/g	10 / 18	9 / 16	56%	10.0	10.0	9.8	42	17	14	Lognormal	33	33		35	--
Magnesium	µg/g	16 / 16	16 / 16	100%	--	--	219	1,670	907	404	Normal	1,084	1,084		1,814	--
Manganese	µg/g	16 / 16	16 / 16	100%	--	--	140	2,200	832	650	Normal	1,117	1,117		1,664	--
Nickel	µg/g	9 / 16	9 / 16	56%	7.5	7.5	11	28	12	8.3	Lognormal	20	20		23	--
Potassium	µg/g	14 / 16	14 / 16	88%	142	142	216	1,180	646	382	Normal	814	814		1,293	--
Sodium	µg/g	9 / 16	9 / 16	56%	50	50	62	282	98	87	Lognormal	198	198		197	--
Vanadium	µg/g	16 / 16	16 / 16	100%	--	--	8.0	112	39	25	Lognormal	59	59		78	--
Zinc	µg/g	10 / 16	10 / 16	63%	17	80	59	293	93	81	Normal	129	129		186	--
Acetone	µg/g	2 / 16	2 / 16	13%	0.032	0.045	0.027	0.031	0.023	0.0030	Lognormal	0.024	0.024		--	--
Benzo(a)anthracene	µg/g	2 / 17	2 / 16	13%	0.17	0.17	0.096	0.33	0.10	0.061	Lognormal	0.12	0.12		--	--
Benzo(b)fluoranthene	µg/g	1 / 17	1 / 16	6%	0.73	0.73	0.57	0.57	0.38	0.051	Lognormal	0.40	0.40		--	--
Chrysene	µg/g	1 / 17	1 / 16	6%	0.27	0.27	0.36	0.36	0.15	0.056	Lognormal	0.17	0.17		--	--
Fluoranthene	µg/g	2 / 17	2 / 16	13%	0.17	0.17	0.17	0.57	0.12	0.12	Lognormal	0.15	0.15		--	--
Methylene Chloride	µg/g	8 / 16	8 / 16	50%	0.0062	0.0067	0.0047	0.0091	0.0049	0.0021	Lognormal	0.0061	0.0061		--	--
Phenanthrene	µg/g	1 / 17	1 / 16	6%	0.17	0.17	0.12	0.12	0.087	0.0088	Lognormal	0.095	0.095		--	--
Pyrene	µg/g	1 / 17	1 / 16	6%	0.97	0.97	0.49	0.49	0.49	0.0012	Lognormal	0.51	0.49	#	--	--
Toluene	µg/g	1 / 16	1 / 16	6%	0.0025	0.0025	0.0025	0.0025	0.0013	0.00031	Lognormal	0.0014	0.0014		--	--
Total Organic Carbon	µg/g	6 / 16	6 / 16	38%	1000	1000	14,700	23,300	7,781	9,958	Lognormal	77,277	23,300	#	--	--
bis(2-Chloroisopropyl) Ether	µg/g	3 / 17	3 / 16	19%	0.17	0.17	0.13	0.18	0.098	0.030	Lognormal	0.11	0.11		--	--

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- *Not applicable (note: background comparison not conducted for organic compounds)*

VOCs—Acetone (0.027 to 0.031 µg/g), methylene chloride (0.0047 to 0.0091 µg/g), and toluene (0.0025 µg/g) were detected in the background sediments with the maximum concentrations occurring at SD-BK-02A, SD-BK-02B, and SD-BK-02D. All three compounds were detected at concentrations near or below the CRL.

SVOCs—SVOCs consisting of bis(2-chloroisopropyl)ether and the PAH compounds benzo(a)anthracene, benzo(b)fluoranthene, chrysene, fluoranthene, phenanthrene, and pyrene were detected in the background sediment samples. These compounds were detected in the sediment samples collected from Talladega Creek upstream of the facility drainage. Bis(2-chloroisopropyl)ether was detected in samples SD-BK-02C, SD-BK-02D, and SD-BK-02E at concentrations near or below the CRL. Most of the PAHs were detected at concentrations at or below the CRL; the maximum PAH concentrations were detected in sample SD-BK-01A.

Pesticides/PCBs—PCBs and pesticides were not detected in any of the background sediment samples.

Summary—Sediment samples were collected from two locations to serve as a background comparison. Seventeen metals were detected in the background sediment samples, including aluminum, arsenic, barium, beryllium, chromium, cobalt, copper, lead, manganese, nickel, vanadium, zinc, and the nutrient metals calcium, iron, magnesium, potassium, and sodium. Explosives compounds were not detected in any of the screening or confirmatory sediment samples collected from the background sediment locations. Three VOCs and seven SVOCs were detected in the background sediment at low (near or below the CRL) concentrations. PCBs and pesticides were not detected in any of the background sediment samples.

4.7.3 Study Area 5–Red Water Storage Basin

The Red Water Storage Basin was used as a settling basin for TNT manufacturing process wastewaters. An entry pipe was located at the southeast corner and an exit flume was located in the southwest corner. From the basin, 10 sediment samples were collected along 3 transects (see Sheet 3-2) and screened in the field for explosives. Two samples (SD-05-0000 and SD-05-4020) were collected from Study Area 5, one at either end of the basin, and sent to the laboratory for confirmatory analysis that included metals, hexavalent chromium, explosives, VOCs, and SVOCs. **Figure 4-48** shows the locations where general contaminant group CEBs were detected. Summary statistics for the Study Area 5 sediment samples are presented in **Table 4-86**. Data summary tables for the sediment samples are included in Appendix K.

Metals—Detected metals did not exceed background concentrations.

Explosives—The nontarget explosive compound HMX (0.499 µg/g) was detected in sample SD-05-4020. HMX does not have a documented history of usage at the site.

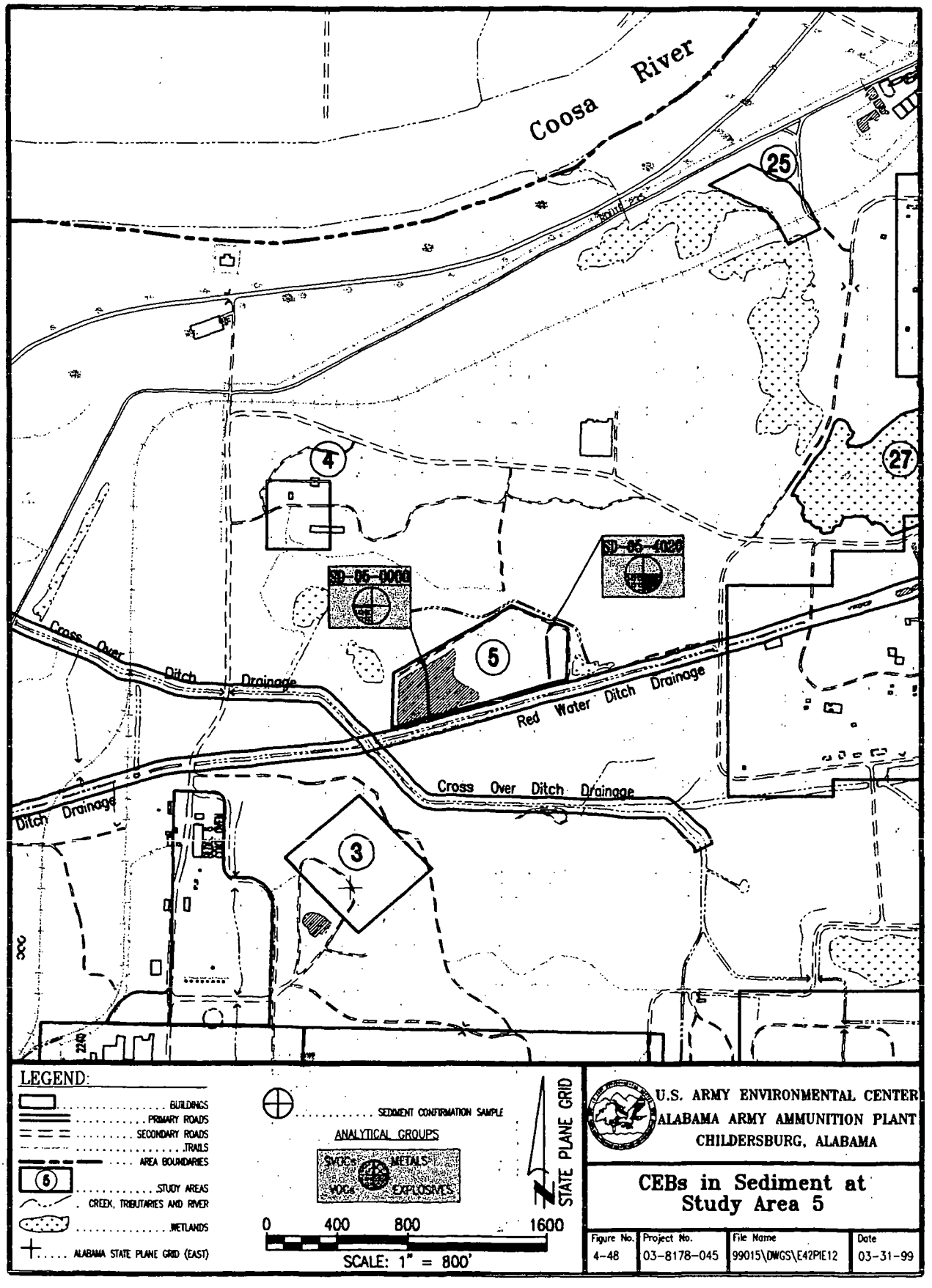

Coosa River
25
27
4
5
3
SD-05-0000
SD-05-4020
Cross Over Ditch Drainage
Red Water Ditch Drainage
Cross Over Ditch Drainage
Ditch Drainage
LEGEND:
BUILDINGS
PRIMARY ROADS
SECONDARY ROADS
TRAILS
AREA BOUNDARIES
STUDY AREAS
CREEK, TRIBUTARIES AND RIVER
WETLANDS
ALABAMA STATE PLANE GRID (EAST)
SEDIMENT CONFIRMATION SAMPLE
ANALYTICAL GROUPS
SVOCs
METALS
VOCs
EXPLOSIVES
STATE PLANE GRID
0 400 800 1600
SCALE: 1" = 800'
U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA
CEBs in Sediment at Study Area 5
Figure No. 4-48
Project No. 03-8178-045
File Name 99015\DWGS\E42PIE12
Date 03-31-99

Table 4-86. Summary Statistics and Exposure Point Concentrations for Sediment at Study Area 5 - Red Water Storage Basin
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:19:37 PM
Run Date: 3/29/99
Exposure Unit: 05__DS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[g]	Background Comparison[g]
Aluminum	µg/g	2 / 2	2 / 2	100%	--	--	7,400	11,000	--	--	Undetermined	--	11,000	#	25,323	[bk]
Barium	µg/g	2 / 2	2 / 2	100%	--	--	65	95	--	--	Undetermined	--	95	#	151	[bk]
Beryllium	µg/g	2 / 2	2 / 2	100%	--	--	0.48	0.67	--	--	Undetermined	--	0.67	#	1.5	[bk]
Calcium	µg/g	2 / 2	2 / 2	100%	--	--	220	361	--	--	Undetermined	--	361	#	2,150	[bk]
Chromium	µg/g	2 / 2	2 / 2	100%	--	--	14	21	--	--	Undetermined	--	21	#	46	[bk]
Cobalt	µg/g	2 / 2	2 / 2	100%	--	--	3.4	3.6	--	--	Undetermined	--	3.6	#	19	[bk]
Copper	µg/g	2 / 2	2 / 2	100%	--	--	7.0	7.9	--	--	Undetermined	--	7.9	#	42	[bk]
Iron	µg/g	2 / 2	2 / 2	100%	--	--	17,000	19,000	--	--	Undetermined	--	19,000	#	46,260	[bk]
Lead	µg/g	2 / 2	2 / 2	100%	--	--	18	29	--	--	Undetermined	--	29	#	35	[bk]
Magnesium	µg/g	2 / 2	2 / 2	100%	--	--	188	524	--	--	Undetermined	--	524	#	1,814	[bk]
Manganese	µg/g	2 / 2	2 / 2	100%	--	--	75	430	--	--	Undetermined	--	430	#	1,664	[bk]
Potassium	µg/g	2 / 2	2 / 2	100%	--	--	242	419	--	--	Undetermined	--	419	#	1,293	[bk]
Sodium	µg/g	2 / 2	2 / 2	100%	--	--	70	98	--	--	Undetermined	--	98	#	197	[bk]
Vanadium	µg/g	2 / 2	2 / 2	100%	--	--	30	39	--	--	Undetermined	--	39	#	78	[bk]
Zinc	µg/g	1 / 2	1 / 2	50%	25	25	33	33	--	--	Undetermined	--	33	#	186	[bk]
Cyclotetramethylenetetranitramine	µg/g	1 / 2	1 / 2	50%	0.16	0.16	0.50	0.50	--	--	Undetermined	--	0.50	#	--	[CEB]
Methylene Chloride	µg/g	2 / 2	2 / 2	100%	--	--	0.0045	0.047	--	--	Undetermined	--	0.047	#	--	[CEB]
Toluene	µg/g	2 / 2	2 / 2	100%	--	--	0.0021	0.041	--	--	Undetermined	--	0.041	#	--	[CEB]
Total Organic Carbon	µg/g	2 / 2	2 / 2	100%	--	--	40,700	43,200	--	--	Undetermined	--	43,200	#	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

VOCs—Methylene chloride (0.0045 to 0.047 µg/g) and toluene (0.0021 to 0.041 µg/g) were detected in both of the confirmatory sediment samples from Study Area 5. Methylene chloride in sample SD-05-4020 and toluene in sample SD-05-0000 were detected at concentrations below the CRL.

Maximum Concentrations	
Analyte	mg/g
Methylene Chloride	0.047
Toluene	0.041

SVOCs—SVOCs were not detected in the sediment samples from the Red Water Storage Basin.

Summary—Two samples (SD-05-0000 and SD-05-4020) were collected from Study Area 5 at the ends of the basin. Inorganic constituents that were detected in the basin sediment did not exceed background concentrations. Organic constituents that were detected in the limited sampling at the site consisted of one nontarget explosive compound (HMX) in SD-05-4020 and two VOCs (methylene chloride and toluene). HMX does not have a documented history of usage at ALAAP.

4.7.4 Study Area 9 – Aniline Sludge Basin

The Aniline Sludge Basin was constructed using native clay, but is otherwise unlined. Liquid wastes and sludges from the production of aniline and oleum in Study Area 8 were deposited in the basin. Samples were collected from the basin sediment, the tar-like material present on a portion of the basin surface, and the sediment beneath the tar. Results are provided in the following sections.

4.7.4.1 Basin Sediment Results

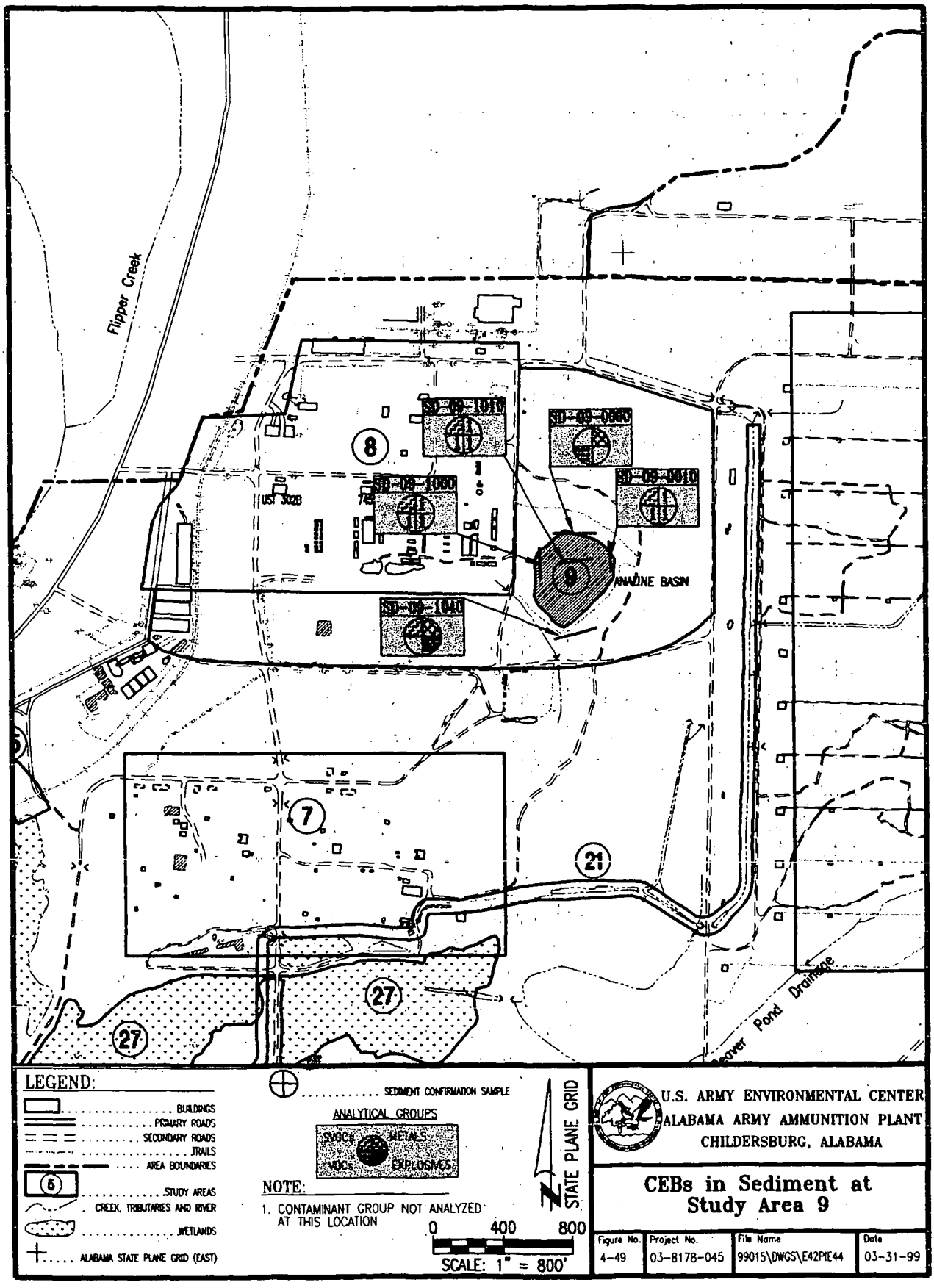
During Phase 1 of the Supplemental RI, five sediment samples (SD-09-0000, SD-09-0010, SD-09-1000, SD-09-1010, SD-09-1040) were collected from locations within the basin, field-screened for explosives (see Sheet 3-2), and analyzed for SVOCs at the laboratory. In addition, two locations (SD-09-0000 and SD-09-1040) were sampled in 1-foot increments with a hand auger to 5 feet BLS (see Sheet 3-2). These samples were screened in the field laboratory for explosives. Samples SD-09-0000 and SD-09-1040 also were analyzed in the offsite laboratory for metals, hexavalent chromium, explosives, VOCs, and SVOCs. The remaining samples were analyzed for SVOCs. **Table 4-87** summarizes the statistics for analytes detected in the basin sediments at Study Area 9. Appendix K provides the data summary tables. The locations of the confirmatory sediment samples and the general contaminant groups detected at Study Area 9 are shown in **Figure 4-49**.

Table 4-87. Summary Statistics and Exposure Point Concentrations for Sediment at Study Area 9 - Aniline Sludge Basin
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:34:09 PM
Run Date: 3/29/99
Exposure Unit: 09__DS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	2 / 2	2 / 2	100%	--	--	5,600	6,900	--	--	Undetermined	--	6,900	#	25,323	[bk]
Arsenic	µg/g	2 / 2	2 / 2	100%	--	--	17	161	--	--	Undetermined	--	161	#	15	[CEB]
Barium	µg/g	2 / 2	2 / 2	100%	--	--	20	53	--	--	Undetermined	--	53	#	151	[bk]
Beryllium	µg/g	2 / 2	2 / 2	100%	--	--	0.39	0.77	--	--	Undetermined	--	0.77	#	1.5	[bk]
Calcium	µg/g	2 / 2	2 / 2	100%	--	--	248	931	--	--	Undetermined	--	931	#	2,150	[bk]
Chromium	µg/g	2 / 2	2 / 2	100%	--	--	10	205	--	--	Undetermined	--	205	#	46	[CEB]
Cobalt	µg/g	1 / 2	1 / 2	50%	2.5	2.5	7.3	7.3	--	--	Undetermined	--	7.3	#	19	[bk]
Copper	µg/g	2 / 2	2 / 2	100%	--	--	19	527	--	--	Undetermined	--	527	#	42	[CEB]
Iron	µg/g	2 / 2	2 / 2	100%	--	--	22,000	410,000	--	--	Undetermined	--	410,000	#	46,260	[CEB]
Lead	µg/g	2 / 2	2 / 2	100%	--	--	31	126	--	--	Undetermined	--	126	#	35	[CEB]
Magnesium	µg/g	1 / 2	1 / 2	50%	138	138	168	168	--	--	Undetermined	--	168	#	1,814	[bk]
Manganese	µg/g	2 / 2	2 / 2	100%	--	--	280	1,800	--	--	Undetermined	--	1,800	#	1,664	[CEB]
Molybdenum	µg/g	1 / 2	1 / 2	50%	4.0	4.0	127	127	--	--	Undetermined	--	127	#	--	[CEB]
Nickel	µg/g	2 / 2	2 / 2	100%	--	--	21	128	--	--	Undetermined	--	128	#	23	[CEB]
Potassium	µg/g	1 / 2	1 / 2	50%	142	142	270	270	--	--	Undetermined	--	270	#	1,293	[bk]
Sodium	µg/g	2 / 2	2 / 2	100%	--	--	108	282	--	--	Undetermined	--	282	#	197	[CEB]
Vanadium	µg/g	2 / 2	2 / 2	100%	--	--	21	135	--	--	Undetermined	--	135	#	78	[CEB]
Zinc	µg/g	2 / 2	2 / 2	100%	--	--	42	451	--	--	Undetermined	--	451	#	186	[CEB]
2,4,6-Trinitrotoluene	µg/g	1 / 2	1 / 2	50%	0.089	0.089	3.4	3.4	--	--	Undetermined	--	3.4	#	--	[CEB]
4-Amino-2,6-Dinitrotoluene	µg/g	1 / 2	1 / 2	50%	0.090	0.090	4.6	4.6	--	--	Undetermined	--	4.6	#	--	[CEB]
Benzo(a)anthracene	µg/g	1 / 5	1 / 5	20%	0.17	0.80	0.31	0.31	0.26	0.16	Normal	0.41	0.31	#	--	[CEB]
Benzo(a)pyrene	µg/g	1 / 5	1 / 5	20%	0.24	1.00	0.21	0.21	0.29	0.20	Normal	0.48	0.21	#	--	[CEB]
Benzo(b)fluoranthene	µg/g	1 / 5	1 / 5	20%	0.73	4.0	0.72	0.72	1.1	0.84	Normal	1.9	0.72	#	--	[CEB]
Benzo(g,h,i)perylene	µg/g	1 / 5	1 / 5	20%	0.25	1.00	0.21	0.21	0.29	0.19	Normal	0.48	0.21	#	--	[CEB]
Benzo(k)fluoranthene	µg/g	1 / 5	1 / 5	20%	0.40	2.0	0.26	0.26	0.53	0.43	Lognormal	3.4	0.26	#	--	[CEB]
Chrysene	µg/g	2 / 5	2 / 5	40%	0.27	1.00	0.45	1.9	0.70	0.69	Lognormal	6.7	1.9	#	--	[CEB]
Indeno(1,2,3-cd)pyrene	µg/g	1 / 5	1 / 5	20%	0.17	0.80	0.23	0.23	0.24	0.16	Normal	0.39	0.23	#	--	[CEB]
N-Nitrosodiphenylamine	µg/g	4 / 5	4 / 5	80%	0.80	0.80	0.60	500	101	223	Lognormal	6.22E+10	500	#	--	[CEB]
Toluene	µg/g	1 / 2	1 / 2	50%	0.0067	0.0067	0.024	0.024	--	--	Undetermined	--	0.024	#	--	[CEB]
Total Organic Carbon	µg/g	2 / 2	2 / 2	100%	--	--	28,000	33,300	--	--	Undetermined	--	33,300	#	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)


Flipper Creek
SD-09-1010
SD-09-0500
SD-09-1000
SD-09-0010
SD-09-1040
UST 302B
8
9
AMMUNE BASIN
7
21
27
27
Beaver Pond Drainage
LEGEND:
BUILDINGS
PRIMARY ROADS
SECONDARY ROADS
TRAILS
AREA BOUNDARIES
STUDY AREAS
CREEK, TRIBUTARIES AND RIVER
WETLANDS
ALABAMA STATE PLANE GRID (EAST)
SEDIMENT CONFIRMATION SAMPLE
ANALYTICAL GROUPS
SVOCs
METALS
VOCs
EXPLOSIVES
NOTE:
1. CONTAMINANT GROUP NOT ANALYZED AT THIS LOCATION
STATE PLANE GRID
0 400 800
SCALE: 1" = 800'
U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA
CEBs in Sediment at Study Area 9
Figure No. 4-49
Project No. 03-8178-045
File Name 99015\DWGS\E42PIE44
Date 03-31-99

Metals—Eleven metals exceeded background in the Study Area 9 basin sediment samples, as shown in the adjacent box. With the exception of sodium, all maximum CEB metals concentrations were detected in sediment sample SD-09-0000, which was collected from the north side of the Aniline Sludge Basin.

Sodium was detected at a maximum concentration at location SD-09-1040 on the south end of the Aniline Sludge Basin.

Maximum Concentrations*	
Analyte	mg/g
Arsenic	161
Chromium	205
Copper	527
Iron	410,000
Lead	126
Manganese	1,800
Molybdenum	127
Nickel	128
Sodium	282
Vanadium	135
Zinc	451

*ANOVA evaluation not conducted because there are fewer than four samples in the data set.

Explosives—TNT (3.38 µg/g), and 4-A-2,6-DNT (4.62 µg/g) were detected in sample SD-09-1040 collected on the south side of the basin. Explosives were not detected in the sediments in the northern part of the basin.

Maximum Concentrations	
Analyte	mg/g
4-A-2,6-DNT	4.62
TNT	3.38

VOCs—An isolated concentration of toluene (0.024 µg/g) was detected in sample SD-09-0000.

SVOCs—SVOCs were detected in basin sediment samples SD-09-0010, SD-09-1000, SD-09-1010, and SD-09-1040. The SVOCs were predominantly PAH compounds and included benzo(a)anthracene (0.31 µg/g), benzo(a)pyrene (0.21µg/g), benzo(g,h,i)perylene (0.21 µg/g), benzo(k)-fluoranthene (0.26 µg/g), chrysene (0.45 to 1.9 µg/g), indeno(1,2,3-cd)pyrene (0.23 µg/g), and N-Nitrosodi-phenylamine (0.6 to 500 µg/g).

Maximum Concentrations*	
Analyte	mg/g
Benzo(a)anthracene	0.31
Benzo(a)pyrene	0.21
Benzo(g,h,i)perylene	0.21
Benzo(k)fluoranthene	0.26
Chrysene	1.9
Indeno(1,2,3-cd)pyrene	0.23
N-Nitrosodiphenylamine	500

*ANOVA evaluation not conducted because there are fewer than four samples in the data set.

Summary—Metals that exceeded background in the sediment in the basin included arsenic, chromium, copper, iron, lead, manganese, molybdenum, nickel, sodium, vanadium, and zinc in sediment samples SD-09-0000 and SD-09-1040. Explosives constituents were detected in only one sample from the south side of the study area. Toluene was the only VOC detected and it was detected in only one sample. Seven SVOCs, including six PAHs and N-Nitrosodiphenylamine, were detected in basin sediment samples. The maximum SVOC concentrations in the sediment were detected in sample SD-09-1010.

4.7.4.2 Study Area 9 – Aniline Sludge Basin – Tar

During Phase 1 of the Supplemental RI, one tar sample (SD-09-TAR) was collected from Study Area 9 and analyzed for SVOCs. During Phase 4A, two samples of residual tar from the

Aniline Sludge Basin (TAR-09-001 and TAR-09-002) were collected and analyzed for VOCs and SVOCs. Sample TAR-09-001 also was analyzed for metals, pesticides, and PCBs. **Table 4-88** summarizes the statistics for constituents detected in the tar samples from Study Area 9. Appendix K provides the data summary tables. The locations of the tar samples and the general contaminant groups detected in Study Area 9 tar samples are shown in **Figure 4-50**.

Metals—Ten metals exceeded background in the Study Area 9 tar samples, as shown in the adjacent box. The maximum concentrations of all metals that exceeded background were detected in tar sample TAR-09-001, which was the northeastern sample collected from within the boundary of the tar.

Maximum Concentrations*	
Analyte	mg/g
Chromium	406
Cobalt	22.2
Copper	705
Iron	470,000
Lead	814
Manganese	2,800
Molybdenum	107
Nickel	384
Sodium	12,100
Zinc	294

*ANOVA evaluation not conducted because there are fewer than four samples in the data set.

VOCs—Benzene (0.17 to 0.24 µg/g) was detected in samples TAR-09-001 and TAR-09-002. Sample SD-09-TAR was not analyzed for VOCs.

SVOCs—SVOCs were detected in tar samples TAR-09-001 and TAR-09-002. The detected compounds consisted of carbazole (30,000 to 60,000µg/g), N-Nitrosodiphenylamine (400,000 to 4,000,000 µg/g), and phenol (1,000 µg/g).

Maximum Concentrations*	
Analyte	mg/g
Carbazole	60,000
N-Nitrosodiphenylamine	4,000,000
Phenol	1,000

Summary—Metals, one VOC, and SVOCs exceeded background in the Study Area 9 tar samples. Metals that exceed background concentrations in tar sample TAR-09-001 included chromium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, sodium, and zinc. One VOC (benzene) was detected in both tar samples analyzed for VOCs at a maximum concentration of 0.24 µg/g. SVOCs detected in the tar samples consisted of carbazole, N-Nitrosodiphenylamine, and phenol.

4.7.4.3 Study Area 9 – Aniline Sludge Basin – Sediments Beneath the Tar

During Phase 4A of the Supplemental RI, eight sediment samples from locations SD-09-001 to SD-09-004 were collected below the surface tar and analyzed for VOCs and SVOCs. Two samples were collected from each location at depths ranging from 1 to 2.5 feet BLS. Sample SD-09-002 also was analyzed for metals. Appendix K provides the data summary tables. The locations of the sediment samples and the general contaminant groups detected at Study Area 9 are shown in Figure 4-50. **Table 4-89** provides the summary statistics for the sediment samples beneath the tar.

Table 4-88. Summary Statistics and Exposure Point Concentrations for Sediment at Study Area 9 Tar - Aniline Sludge Basin
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:38:58 PM
Run Date: 3/29/99
Exposure Unit: 09_DS3

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	1 / 1	1 / 1	100%	--	--	3,200	3,200	--	--	Undetermined	--	3,200	#	25,323	[bk]
Arsenic	µg/g	1 / 2	1 / 1	100%	--	--	12	12	--	--	Undetermined	--	12	#	15	[bk]
Barium	µg/g	2 / 2	1 / 1	100%	--	--	41	43	--	--	Undetermined	--	43	#	151	[bk]
Calcium	µg/g	1 / 1	1 / 1	100%	--	--	829	829	--	--	Undetermined	--	829	#	2,150	[bk]
Chromium	µg/g	1 / 2	1 / 1	100%	--	--	406	406	--	--	Undetermined	--	406	#	46	[CEB]
Cobalt	µg/g	1 / 1	1 / 1	100%	--	--	22	22	--	--	Undetermined	--	22	#	19	[CEB]
Copper	µg/g	1 / 1	1 / 1	100%	--	--	705	705	--	--	Undetermined	--	705	#	42	[CEB]
Iron	µg/g	1 / 1	1 / 1	100%	--	--	470,000	470,000	--	--	Undetermined	--	470,000	#	46,260	[CEB]
Lead	µg/g	1 / 2	1 / 1	100%	--	--	814	814	--	--	Undetermined	--	814	#	35	[CEB]
Magnesium	µg/g	1 / 1	1 / 1	100%	--	--	362	362	--	--	Undetermined	--	362	#	1,814	[bk]
Manganese	µg/g	1 / 1	1 / 1	100%	--	--	2,800	2,800	--	--	Undetermined	--	2,800	#	1,664	[CEB]
Molybdenum	µg/g	1 / 1	1 / 1	100%	--	--	107	107	--	--	Undetermined	--	107	#	--	[CEB]
Nickel	µg/g	1 / 1	1 / 1	100%	--	--	384	384	--	--	Undetermined	--	384	#	23	[CEB]
Sodium	µg/g	1 / 1	1 / 1	100%	--	--	12,100	12,100	--	--	Undetermined	--	12,100	#	197	[CEB]
Vanadium	µg/g	1 / 1	1 / 1	100%	--	--	69	69	--	--	Undetermined	--	69	#	78	[bk]
Zinc	µg/g	1 / 1	1 / 1	100%	--	--	294	294	--	--	Undetermined	--	294	#	186	[CEB]
Benzene	µg/g	2 / 2	2 / 2	100%	--	--	0.17	0.24	--	--	Undetermined	--	0.24	#	--	[CEB]
Carbazole	µg/g	2 / 2	2 / 2	100%	--	--	30,000	60,000	--	--	Undetermined	--	60,000	#	--	[CEB]
Cyanide	µg/g	1 / 1	1 / 1	100%	--	--	0.26	0.26	--	--	Undetermined	--	0.26	#	--	[CEB]
N-Nitrosodiphenylamine	µg/g	2 / 3	2 / 3	67%	20,000	20,000	400,000	4.00E+06	--	--	Undetermined	--	4.00E+06	#	--	[CEB]
Phenol	µg/g	1 / 3	1 / 3	33%	200	20,000	1000	1000	--	--	Undetermined	--	1000	#	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

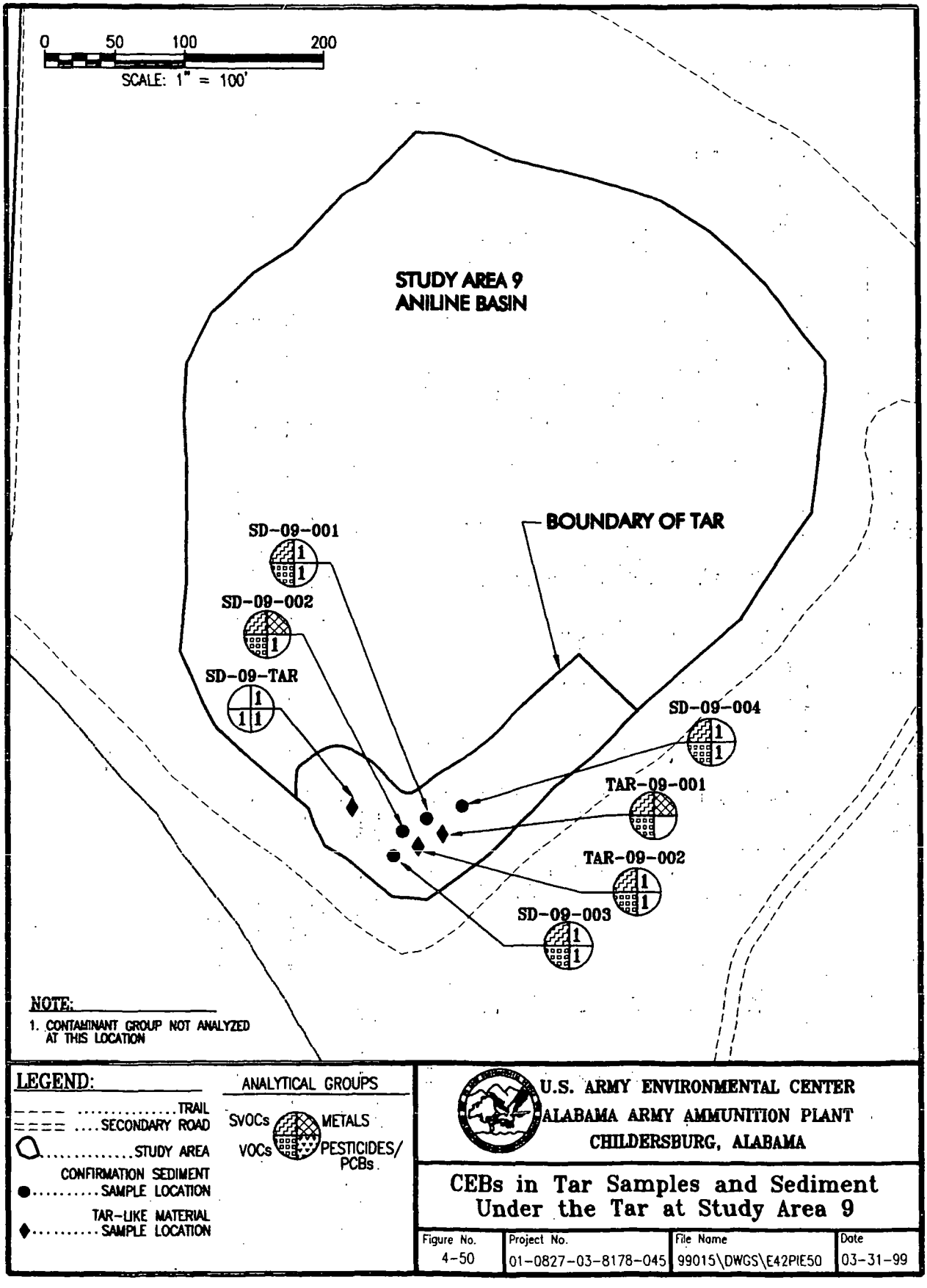

0 50 100 200
SCALE: 1" = 100'
STUDY AREA 9
ANILINE BASIN
BOUNDARY OF TAR
SD-09-001
SD-09-002
SD-09-TAR
SD-09-004
TAR-09-001
TAR-09-002
SD-09-003
NOTE:
1. CONTAMINANT GROUP NOT ANALYZED AT THIS LOCATION
LEGEND:
TRAIL
SECONDARY ROAD
STUDY AREA
CONFIRMATION SEDIMENT SAMPLE LOCATION
TAR-LIKE MATERIAL SAMPLE LOCATION
ANALYTICAL GROUPS
SVOCs
METALS
VOCs
PESTICIDES/ PCBs
U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA
CEBs in Tar Samples and Sediment Under the Tar at Study Area 9
Figure No. 4-50
Project No. 01-0827-03-8178-045
File Name 99015\DWGS\E42PIE50
Date 03-31-99

Table 4-89. Summary Statistics and Exposure Point Concentrations for Sediment at Study Area 9 Beneath Tar - Aniline Sludge Basin
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:36:12 PM
Run Date: 3/29/99
Exposure Unit: 09__DS2

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	2 / 2	2 / 2	100%	--	--	22,400	26,900	--	--	Undetermined	--	26,900	#	25,323	[CEB]
Antimony	µg/g	2 / 2	2 / 2	100%	--	--	50	62	--	--	Undetermined	--	62	#	--	[CEB]
Arsenic	µg/g	2 / 2	2 / 2	100%	--	--	9.8	18	--	--	Undetermined	--	18	#	15	[CEB]
Barium	µg/g	2 / 2	2 / 2	100%	--	--	48	76	--	--	Undetermined	--	76	#	151	[bk]
Calcium	µg/g	2 / 2	2 / 2	100%	--	--	205	612	--	--	Undetermined	--	612	#	2,150	[bk]
Chromium	µg/g	2 / 2	2 / 2	100%	--	--	68	117	--	--	Undetermined	--	117	#	46	[CEB]
Copper	µg/g	2 / 2	2 / 2	100%	--	--	13	17	--	--	Undetermined	--	17	#	42	[bk]
Iron	µg/g	2 / 2	2 / 2	100%	--	--	59,200	81,000	--	--	Undetermined	--	81,000	#	46,260	[CEB]
Lead	µg/g	2 / 2	2 / 2	100%	--	--	18	21	--	--	Undetermined	--	21	#	35	[bk]
Magnesium	µg/g	2 / 2	2 / 2	100%	--	--	545	603	--	--	Undetermined	--	603	#	1,814	[bk]
Manganese	µg/g	2 / 2	2 / 2	100%	--	--	100	368	--	--	Undetermined	--	368	#	1,664	[bk]
Mercury	µg/g	1 / 2	1 / 2	50%	0.050	0.050	0.088	0.088	--	--	Undetermined	--	0.088	#	--	[CEB]
Nickel	µg/g	2 / 2	2 / 2	100%	--	--	5.4	6.9	--	--	Undetermined	--	6.9	#	23	[bk]
Potassium	µg/g	2 / 2	2 / 2	100%	--	--	440	463	--	--	Undetermined	--	463	#	1,293	[bk]
Sodium	µg/g	2 / 2	2 / 2	100%	--	--	2,890	3,100	--	--	Undetermined	--	3,100	#	197	[CEB]
Vanadium	µg/g	2 / 2	2 / 2	100%	--	--	80	104	--	--	Undetermined	--	104	#	78	[CEB]
Zinc	µg/g	2 / 2	2 / 2	100%	--	--	29	32	--	--	Undetermined	--	32	#	186	[bk]
Benzoic Acid	µg/g	1 / 1	1 / 1	100%	--	--	0.41	0.41	--	--	Undetermined	--	0.41	#	--	[CEB]
Carbazole	µg/g	8 / 8	8 / 8	100%	--	--	0.13	8.7	3.3	3.5	Normal	5.6	5.6		--	[CEB]
N-Nitrosodiphenylamine	µg/g	8 / 8	8 / 8	100%	--	--	2.9	100	41	42	Lognormal	498	100	#	--	[CEB]
Phenol	µg/g	3 / 8	3 / 8	38%	0.052	0.052	0.72	4.2	0.73	1.4	Lognormal	218	4.2	#	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Metals—Eight metals exceeded background in the samples from the sediment beneath the tar. Maximum concentrations of all of the CEB metals were detected in the two samples from location SD-09-002.

Maximum Concentrations*	
Analyte	mg/g
Aluminum	26,900
Antimony	62
Arsenic	17.6
Chromium	117
Iron	81,000
Mercury	0.0878
Sodium	3,100
Vanadium	104

*ANOVA evaluation not conducted because there are fewer than four samples in the data set.

VOCs—VOCs were not detected in any of the sediment samples from beneath the tar.

SVOCs—SVOCs were detected in all of the sediment samples beneath the tar. Carbazole (0.13 to 8.7 µg/g), N-Nitrosodiphenylamine (2.94 to 100 µg/g), and phenol (0.72 to 4.2 µg/g) were detected in the sediment and also were detected at elevated concentrations in the tar. The compounds were detected to a depth of 2.5 feet BLS.

Maximum Concentrations*	
Analyte	mg/g
Benzoic Acid	0.41
Carbazole	8.7
N-Nitrosodiphenylamine	100
Phenol	4.2

Summary—Metals and SVOCs were detected above background concentrations in the sediment samples beneath the tar. The highest concentrations of metals were detected in samples from location SD-09-002. Carbazole, N-Nitrosodiphenylamine, and phenol were detected in the sediment and also were detected at elevated concentrations in the tar. VOCs were not detected in the sediment samples underlying the tar in the Aniline Sludge Basin.

4.7.5 Study Area 16 – Flashing Ground

The Flashing Ground consists of four trenches that were used for burning trash and explosives materials. During Phase 3 of the Supplemental RI, one sediment sample was collected from a drainage area north of Study Area 16. The sample was analyzed at the laboratory for metals and explosives. **Figure 4-51** shows the sample location and the general contaminant group CEBs detected. Data summary tables for the sediment sample are provided in Appendix K. Summary statistics for the Study Area 16 sediment sample are presented in **Table 4-90**.

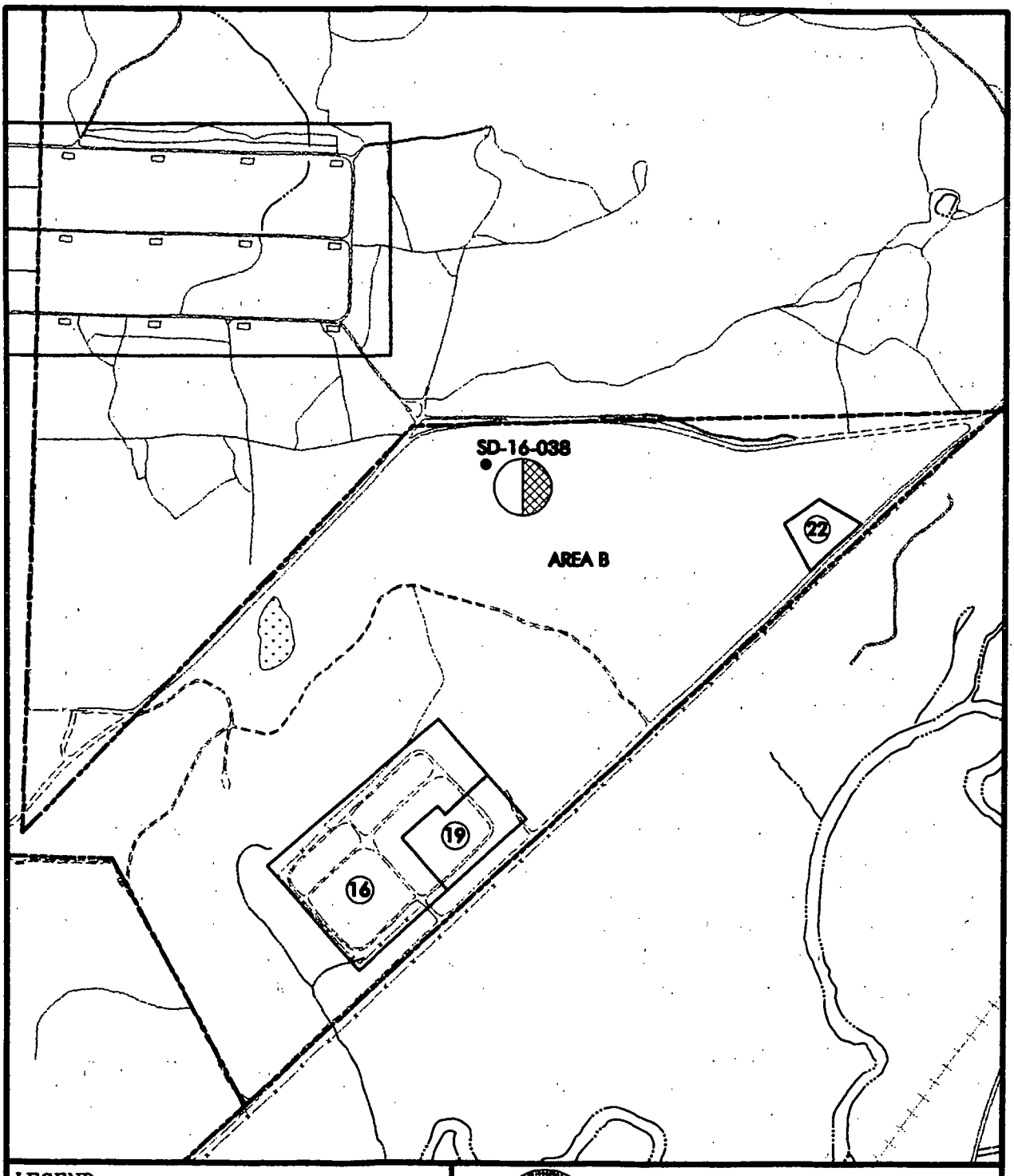
Metals—Three metals were detected at concentrations exceeding background in the Study Area 16 sediment sample. The adjacent box presents the concentrations of these CEB metals.

Maximum Concentrations*	
Analyte	mg/g
Selenium	0.586
Sodium	406
Thallium	0.238

*ANOVA evaluation not conducted because there are fewer than four samples in the data set.

Explosives—Explosives were not detected in the Study Area 16 sediment sample.

Summary—Three metals (selenium, sodium, and thallium) were detected above background in the Study Area 16 sediment sample. Explosives were not detected.



LEGEND:

- - - - .....TRAIL
= = = = ...SECONDARY ROAD
(16) .....STUDY AREA
CONFIRMATION SEDIMENT
●.....SAMPLE LOCATION

ANALYTICAL GROUPS

EXPLOSIVES METALS

U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

CEBs in Sediment at Study Area 16

Figure No.	Project No.	File Name	Date
4-51	01-0827-03-8178-045	99015\DWGS\E42PIE50	03-31-99

Table 4-90. Summary Statistics and Exposure Point Concentrations for Sediment at Study Area 16 - Flashing Ground
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:52:37 PM
Run Date: 3/29/99
Exposure Unit: 16__DS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	1 / 1	1 / 1	100%	--	--	5,660	5,660	--	--	Undetermined	--	5,660	#	25,323	[bk]
Arsenic	µg/g	1 / 1	1 / 1	100%	--	--	3.0	3.0	--	--	Undetermined	--	3.0	#	15	[bk]
Barium	µg/g	1 / 1	1 / 1	100%	--	--	58	58	--	--	Undetermined	--	58	#	151	[bk]
Calcium	µg/g	1 / 1	1 / 1	100%	--	--	299	299	--	--	Undetermined	--	299	#	2,150	[bk]
Chromium	µg/g	1 / 1	1 / 1	100%	--	--	9.8	9.8	--	--	Undetermined	--	9.8	#	46	[bk]
Copper	µg/g	1 / 1	1 / 1	100%	--	--	5.6	5.6	--	--	Undetermined	--	5.6	#	42	[bk]
Iron	µg/g	1 / 1	1 / 1	100%	--	--	6,800	6,800	--	--	Undetermined	--	6,800	#	46,260	[bk]
Lead	µg/g	1 / 1	1 / 1	100%	--	--	15	15	--	--	Undetermined	--	15	#	35	[bk]
Manganese	µg/g	1 / 1	1 / 1	100%	--	--	134	134	--	--	Undetermined	--	134	#	1,664	[bk]
Potassium	µg/g	1 / 1	1 / 1	100%	--	--	164	164	--	--	Undetermined	--	164	#	1,293	[bk]
Selenium	µg/g	1 / 1	1 / 1	100%	--	--	0.59	0.59	--	--	Undetermined	--	0.59	#	--	[CEB]
Sodium	µg/g	1 / 1	1 / 1	100%	--	--	406	406	--	--	Undetermined	--	406	#	197	[CEB]
Thallium	µg/g	1 / 1	1 / 1	100%	--	--	0.24	0.24	--	--	Undetermined	--	0.24	#	--	[CEB]
Vanadium	µg/g	1 / 1	1 / 1	100%	--	--	24	24	--	--	Undetermined	--	24	#	78	[bk]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

4.7.6 Study Area 21 – Red Water Ditch

Roy F. Weston collected shallow sediment samples on transects spaced at 50-foot intervals along the Red Water Ditch throughout the manufacturing area (Weston 1995). The sediment samples were analyzed in the laboratory for seven explosives and lead. Portions of the Red Water Ditch with explosives concentrations exceeding 647 µg/g TNT were excavated until concentrations in the sediment reached 100 µg/g of TNT. These sediments then were incinerated. Sediment samples were collected subsequent to excavation for confirmatory analysis of TNT, lead, and tetryl, and results are summarized in **Table 4-91**. The excavated portion of Study Area 21 is shown on **Sheet 4-9**. The Roy F. Weston sampling results are presented in Appendix L, and were included in the statistical analysis.

During Phase 1 of the Supplemental RI, shallow sediment samples were collected in areas outside those investigated by Roy F. Weston. These locations are shown on Sheet 3-2. A total of 236 sediment samples from 47 transects along the Red Water Ditch were screened in the field for TNT. At an additional four locations, hand augers were used to collect sediment samples to depths of 5 feet BLS at 1-foot intervals. Each of these 20 samples was screened in the field for TNT. At five locations, confirmatory samples were collected along transects. Five samples were collected from each transect, with the "A" sample collected on the left-most bank looking upstream. Sample identifications followed across the stream from left to right (looking upstream) from "B" through "E." Sample "C" was collected in the center of the stream. Confirmatory samples were analyzed for metals, explosives, VOCs, and SVOCs. During Phase 2, additional samples were collected from location SD-21-170B for metals analysis in conjunction with the bioassays. An additional sample also was collected at SD-21-500 at 5 feet BLS for metals and explosives analysis based on the Phase 1 results. The summary statistics for the sediments collected at the Red Water Ditch are presented in Table 4-91 and **Table 4-92**. Appendix K provides the summary tables for data collected by SAIC. The locations of the confirmatory sediment samples and the general contaminant group CEBs detected are shown in **Figure 4-52**. Lead and arsenic results for confirmatory analysis of sediments are shown on **Sheets 4-10** and **4-11**, respectively. **Sheet 4-12** shows laboratory confirmatory results for 2,4-DNT.

Maximum Concentrations*		
Analyte (µg/g)	0-<1ft (µg/g)	1-10ft (µg/g)
Aluminum	**49,000**	
Arsenic	**52.9**	
Barium	**4,100**	
Beryllium	**3.48**	
Calcium	41,000	
Chromium	**294**	
Copper	105	
Iron	**93,000**	
Lead	622	328**
Magnesium	5,780	
Manganese	21,000	
Mercury	**1**	
Molybdenum	**13.3**	
Nickel	23.3	
Potassium	2,680	
Sodium	257	
Vanadium	**133**	

* Metals also determined to exceed background based on ANOVA evaluation are shown in bold.

** Roy F. Weston data.

Metals—Seventeen metals exceeded background in the Study Area 21 surface sediment, as shown in the adjacent box. Lead, which was the only metal analyzed for in the 1- to

Table 4-91. Summary Statistics and Exposure Point Concentrations for Subsurface Sediment at Study Area 21 - Red Water Ditch
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:11:41 PM
Run Date: 3/29/99
Exposure Unit: 21__DS2

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Lead	µg/g	26 / 26	26 / 26	100%	--	--	7.0	328	30	62	Lognormal	34	34		35	[CEB][ANOVA]
2,4,6-Trinitrotoluene	µg/g	12 / 25	12 / 25	48%	0.50	0.50	0.97	50	4.5	10	Lognormal	15	15		--	[CEB]
Tetryl	µg/g	13 / 25	13 / 25	52%	0.50	0.50	0.64	180	19	40	Lognormal	404	180	#	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-92. Summary Statistics and Exposure Point Concentrations for Surface Sediment at Study Area 21 - Red Water Ditch
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:09:47 PM
Run Date: 3/29/99
Exposure Unit: 21__DS1

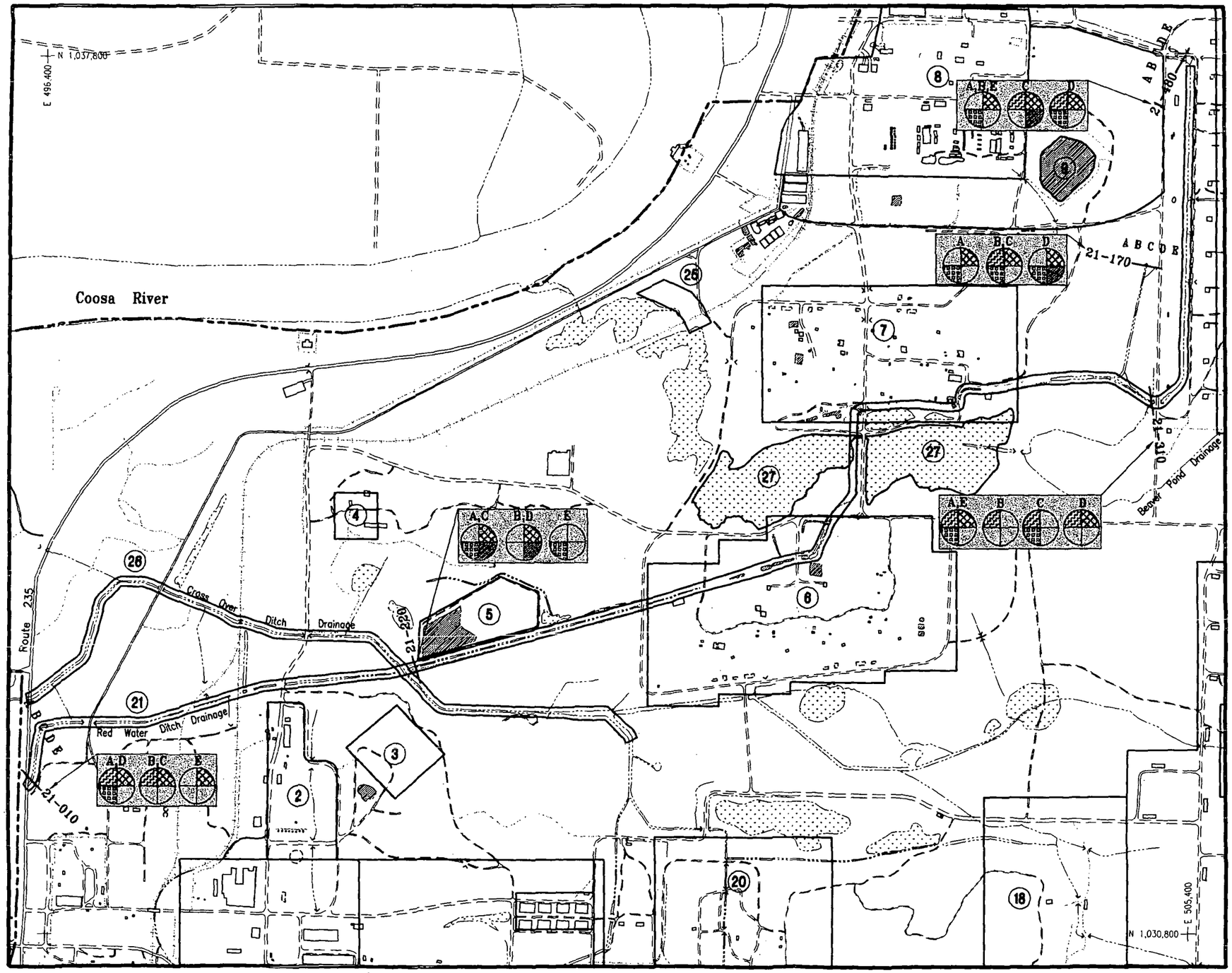
Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]	2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	26 / 26	24 / 24	100%	--	--	13,000	49,000	23,897	9,320	Lognormal	27,561	27,561	25,323	[CEB]
Arsenic	µg/g	14 / 26	12 / 24	50%	13	13	16	53	16	11	Lognormal	22	22	15	[CEB]
Barium	µg/g	24 / 24	24 / 24	100%	--	--	71	4,100	360	847	Lognormal	417	417	151	[CEB]
Beryllium	µg/g	24 / 24	24 / 24	100%	--	--	0.71	3.5	1.3	0.65	Lognormal	1.6	1.6	1.5	[CEB]
Calcium	µg/g	24 / 24	24 / 24	100%	--	--	348	41,000	5,741	9,792	Lognormal	12,573	12,573	2,150	[CEB][ANOVA]
Chromium	µg/g	17 / 24	17 / 24	71%	25	131	20	294	45	55	Lognormal	57	57	46	[CEB]
Cobalt	µg/g	19 / 24	19 / 24	79%	2.5	2.5	3.5	17	7.0	4.7	Normal	8.7	8.7	19	[bk]
Copper	µg/g	24 / 24	24 / 24	100%	--	--	9.9	105	29	22	Lognormal	37	37	42	[CEB][ANOVA]
Iron	µg/g	26 / 26	24 / 24	100%	--	--	20,000	93,000	45,104	19,564	Lognormal	52,815	52,815	46,260	[CEB]
Lead	µg/g	111 / 112	109 / 110	99%	10.0	10.0	5.1	622	34	42	Lognormal	37	37	35	[CEB][ANOVA]
Magnesium	µg/g	24 / 24	24 / 24	100%	--	--	458	5,780	1,322	1,316	Lognormal	1,733	1,733	1,814	[CEB][ANOVA]
Manganese	µg/g	24 / 24	24 / 24	100%	--	--	121	21,000	1,875	4,327	Lognormal	2,901	2,901	1,664	[CEB][ANOVA]
Mercury	µg/g	12 / 26	10 / 24	42%	0.087	0.087	0.13	1.00	0.18	0.24	Lognormal	0.29	0.29	--	[CEB]
Molybdenum	µg/g	5 / 24	5 / 24	21%	4.0	4.0	5.2	13	3.3	3.0	Lognormal	4.1	4.1	--	[CEB]
Nickel	µg/g	16 / 24	16 / 24	67%	7.5	7.5	11	23	12	6.7	Lognormal	17	17	23	[CEB][ANOVA]
Potassium	µg/g	24 / 24	24 / 24	100%	--	--	408	2,680	932	523	Lognormal	1,127	1,127	1,293	[CEB][ANOVA]
Sodium	µg/g	14 / 24	14 / 24	58%	50	50	63	257	74	57	Lognormal	107	107	197	[CEB][ANOVA]
Vanadium	µg/g	24 / 24	24 / 24	100%	--	--	42	133	69	24	Lognormal	78	78	78	[CEB]
Zinc	µg/g	13 / 24	13 / 24	54%	43	118	35	181	64	38	Lognormal	80	80	186	[bk]
1,3,5-Trinitrobenzene	µg/g	1 / 30	1 / 30	3%	0.094	0.50	0.50	0.50	0.096	0.11	Lognormal	0.12	0.12	--	[CEB]
2,4,6-Trinitrotoluene	µg/g	9 / 110	9 / 110	8%	0.079	0.50	0.094	3.9	0.31	0.55	Lognormal	0.35	0.35	--	[CEB]
2,4-Dinitrotoluene	µg/g	2 / 30	2 / 30	7%	0.054	0.50	0.055	0.40	0.085	0.11	Lognormal	0.12	0.12	--	[CEB]
2-Amino-4,6-Dinitrotoluene	µg/g	1 / 30	1 / 30	3%	0.075	0.50	0.50	0.50	0.095	0.11	Lognormal	0.13	0.13	--	[CEB]
4-Amino-2,6-Dinitrotoluene	µg/g	1 / 24	1 / 24	4%	0.090	0.090	0.44	0.44	0.061	0.080	Lognormal	0.066	0.066	--	[CEB]
Acetone	µg/g	2 / 24	2 / 24	8%	0.045	0.20	0.14	0.27	0.045	0.057	Lognormal	0.055	0.055	--	[CEB]
Benzo(a)anthracene	µg/g	7 / 24	7 / 24	29%	0.17	0.17	0.11	0.63	0.15	0.14	Lognormal	0.19	0.19	--	[CEB]
Benzo(a)pyrene	µg/g	7 / 24	7 / 24	29%	0.24	0.24	0.21	0.73	0.21	0.18	Lognormal	0.27	0.27	--	[CEB]
Benzo(b)fluoranthene	µg/g	4 / 24	4 / 24	17%	0.73	0.73	0.61	1.8	0.51	0.38	Lognormal	0.59	0.59	--	[CEB]
Benzo(g,h,i)perylene	µg/g	2 / 24	2 / 24	8%	0.25	0.25	0.30	0.34	0.14	0.055	Lognormal	0.15	0.15	--	[CEB]
Benzoic Acid	µg/g	4 / 24	4 / 24	17%	0.92	0.92	13	32	3.5	7.7	Lognormal	5.4	5.4	--	[CEB]
Chrysene	µg/g	5 / 24	5 / 24	21%	0.27	0.27	0.25	1.1	0.23	0.24	Lognormal	0.29	0.29	--	[CEB]
Fluoranthene	µg/g	6 / 24	6 / 24	25%	0.17	0.17	0.25	0.67	0.18	0.19	Lognormal	0.24	0.24	--	[CEB]
Indeno(1,2,3-cd)pyrene	µg/g	5 / 24	5 / 24	21%	0.17	0.17	0.20	0.35	0.13	0.087	Lognormal	0.15	0.15	--	[CEB]
Methylethylketone	µg/g	5 / 24	5 / 24	21%	0.0051	0.0051	0.0100	0.036	0.0064	0.0088	Lognormal	0.0086	0.0086	--	[CEB]
Phenanthrene	µg/g	2 / 24	2 / 24	8%	0.17	0.17	0.23	0.64	0.11	0.12	Lognormal	0.13	0.13	--	[CEB]
Pyrene	µg/g	1 / 24	1 / 24	4%	0.97	0.97	0.76	0.76	0.50	0.056	Lognormal	0.53	0.53	--	[CEB]
Tetryl	µg/g	2 / 31	2 / 31	6%	0.093	0.50	0.14	122	4.0	22	Lognormal	0.63	0.63	--	[CEB]
Toluene	µg/g	14 / 24	14 / 24	58%	0.0025	0.0025	0.0034	0.078	0.011	0.017	Lognormal	0.026	0.026	--	[CEB]
Total Organic Carbon	µg/g	24 / 24	24 / 24	100%	--	--	7,710	199,000	45,317	42,570	Lognormal	64,644	64,644	--	[CEB]
Total Xylene	µg/g	1 / 24	1 / 24	4%	0.0075	0.0075	0.0054	0.0054	0.0038	0.00034	Lognormal	0.0043	0.0043	--	[CEB]

Table 4-92. Summary Statistics and Exposure Point Concentrations for Surface Sediment at Study Area 21 - Red Water Ditch (Continued)
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:09:47 PM
Run Date: 3/29/99
Exposure Unit: 21__DS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]	2 x BK Mean[d]	Background Comparison[g]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] *For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).*
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit *test coefficients is greater than the critical value, the distribution is assumed to be lognormal.*
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)



LEGEND:

- BUILDINGS
- PRIMARY ROADS
- SECONDARY ROADS
- TRAILS
- FENCE
- AREA BOUNDARIES
- STUDY AREAS
- RAIL ROAD
- CREEK, TRIBUTARIES AND RIVER
- WETLANDS
- PONDS, IMPOUNDMENTS
- GRID BASED ON ALABAMA STATE PLANE EAST
- SEDIMENT SAMPLE TRANSECTS (TYPICAL) STREAM FLOW UP RIVER
- SEDIMENT CONFIRMATION SAMPLE

ANALYTICAL GROUPS
SVOCs METALS
VOCs EXPLOSIVES

0 600 900 1800
SCALE: 1" = 900'
STATE PLANE GRID

U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

CEBs in Sediment at Study Area 21

Figure No.	Project No.	File Name	Date
4-52	01-0827-03-8178-045	99015\DWGS\E42PIE13	03-31-99

10-foot BLS sediment horizon, is a CEB for the shallow subsurface sediment. The maximum concentrations of seven of the surface sediment CEBs (aluminum, arsenic, barium, lead, mercury, molybdenum, and vanadium) were detected in samples from transect location SD-21-170, which was near the northeast end of the ditch. Transect location SD-21-010 contained the maximum concentrations of five CEB metals (beryllium, calcium, magnesium, potassium, and sodium), four of which are essential nutrients. Chromium, iron, and nickel were detected at maximum concentrations at transect SD-21-310, while copper and manganese concentrations were maximums at transect SD-21-480. More maximum metals concentrations (seven) were detected in "A" samples than in "B," "C," or "D" samples. "C" samples from the center of the stream had the fewest (two) maximum metals concentrations.

Lead was a CEB in the shallow subsurface sediment samples collected by Roy F. Weston. All shallow subsurface lead concentrations were below 44 µg/g, with the exception of the maximum concentration (328 µg/g), which was detected in sample 21EXCF1279.

Explosives—The explosives compounds 1,3,5-TNB (0.5 µg/g), TNT (0.0939 to 3.87 µg/g), 2,4-DNT (0.0549 to 0.397 µg/g), tetryl (0.142 to 122 µg/g), and the explosives breakdown products 2-A-4,6-DNT (0.498 µg/g) and 4-A-2,6-DNT (0.437 µg/g) were detected in sediment samples from within the Red Water Ditch during sampling by Roy F. Weston and during the Supplemental RI. The maximum explosives concentrations were detected at transect locations SD-21-170 and SD-21-220 and at Roy F. Weston sample locations 21CPCF617 (surface), 21-76B (shallow subsurface), and 21-130A (shallow subsurface).

Maximum Concentrations		
Analyte (µg/g)	0-<1ft (µg/g)	1-10ft (µg/g)
1,3,5-TNB	0.5	
2,4-DNT	0.397	
TNT	3.87	50*
Tetryl	122*	180*
2-A-4,6-DNT	0.498	
4-A-2,6-DNT	0.437	

* Roy F. Weston data.

In the 256 sediment samples collected during the Supplemental RI and screened in the field, the average TNT concentration was 4.1 µg/g and only 1 sample (SD-21-180B) exceeded 15 µg/g. TNT was detected in sample SD-21-180B at 120 µg/g. The maximum concentration detected in the sediments collected with hand augers was 16.9 µg/g from 1 foot BLS. Five explosives compounds (TNT, 2,4-DNT, 2-A-4,6-DNT, 4-A-2,6-DNT, and tetryl) were detected in the sediment samples collected for laboratory confirmatory analysis, all in transect SD-21-220, location "A." This transect is located just below the outlet of Study Area 5 (see Sheet 4-12).

VOCs—Acetone (0.14 to 0.27 µg/g), MEK (0.01 to 0.036 µg/g), toluene (0.0034 to 0.078 µg/g), and xylenes (0.0054 µg/g) were detected at all five transect locations within Study Area 21. The maximum concentrations were detected along transects SD-21-170, SD-21-220, and SD-21-310. Total xylenes were detected at a concentration below the CRL.

Maximum Concentrations	
Analyte (µg/g)	0-<1ft (µg/g)
Acetone	0.27
MEK	0.036
Toluene	0.078
Total Xylenes	0.0054

SVOCs—Nine of the ten SVOCs (all except benzoic acid) that were detected in the Red Water Ditch sediments were PAHs. All PAH detections except one were in sediments associated with sample locations on transects SD-21-170, SD-21-310, and SD-21-480 located between Study Areas 7 and 10. Benzo(a)anthracene was detected at a concentration below the CRL in one sample from transect SD-21-010. Benzoic acid was detected in four samples from transects SD-21-010 and SD-21-480.

Maximum Concentrations	
Analyte (µg/g)	0-<1ft (µg/g)
Benzo(a)anthracene	0.63
Benzo(a)pyrene	0.73
Benzo(b)fluoranthene	1.8
Benzoic acid	32
Benzo(g,h,i)perylene	0.34
Chrysene	1.1
Fluoranthene	0.67
Indeno(1,2,3-cd)pyrene	0.35
Phenanthrene	0.64
Pyrene	0.76

Summary—Roy F. Weston investigated and remediated portions of Study Area 21 before the Supplemental RI sampling effort. Results from sample data collected to confirm remediation, as well as Supplemental RI data collected outside the area investigated by Roy F. Weston, indicate that metals, explosives, VOCs, and SVOCs exceeded background in the sediment samples from Study Area 21.

Seventeen metals exceeded background in the surface sediment samples, with transect SD-21-170 having samples with the highest concentrations. In the shallow subsurface sediment, lead, which was the only metal analyzed for, exceeded background. Only one lead concentration in the shallow subsurface sediment exceeded 44 µg/g.

Four VOCs were detected in the surface sediment, with maximum concentrations at locations throughout the Red Water Ditch. All VOC concentrations were less than 0.3 µg/g. Ten SVOCs, nine of which were PAHs, were detected in the surface sediment. The majority of SVOC detections were from transects located between Study Areas 7 and 10.

4.7.7 Study Area 26 – Crossover Ditch

During Phase 1 of the Supplemental RI, 396 sediment samples were collected from 75 transects spaced across the Crossover Ditch and its tributaries, from Study Area 17 westward to the Coosa River. The samples were screened for explosives in the field. In addition, at four locations, hand augers were used to collect samples to 5 feet BLS at 1-foot intervals. These samples also were screened for explosives. Forty-eight samples from nine transects were collected for confirmatory analysis of metals, explosives, VOCs, and SVOCs. Four samples were analyzed for hexavalent chromium. The samples were collected across the transect, with the "A" location on the left bank looking upstream. Samples "A" through "E" were collected across the stream, with sample "C" located in the center of the stream. Only samples "B" and "D" were collected along transect SD-26-320. During Phase 2, three additional samples were collected from location SD-26-710C and analyzed for metals. One sample also was collected from each of three locations (SD-27-035, SD-27-036, and SD-27-037) and analyzed for explosives and metals. **Table 4-93**

Table 4-93. Summary Statistics and Exposure Point Concentrations for Sediment at Study Area 26 - Crossover Ditch
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:26:43 PM
Run Date: 3/29/99
Exposure Unit: 26__DS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	47 / 47	46 / 46	100%	--	--	5,020	42,000	14,516	6,643	Lognormal	16,392	16,392		25,323	[CEB][ANOVA]
Arsenic	µg/g	26 / 47	25 / 46	54%	13	13	9.0	370	30	53	Lognormal	36	36		15	[CEB]
Barium	µg/g	45 / 45	45 / 45	100%	--	--	15	637	112	98	Lognormal	141	141		151	[CEB][ANOVA]
Beryllium	µg/g	39 / 45	39 / 45	87%	0.25	0.50	0.39	3.8	0.92	0.75	Lognormal	1.2	1.2		1.5	[CEB][ANOVA]
Cadmium	µg/g	3 / 45	3 / 45	7%	0.43	0.70	0.60	2.8	0.31	0.42	Lognormal	0.32	0.32		--	[CEB]
Calcium	µg/g	41 / 45	41 / 45	91%	109	109	204	44,000	2,933	6,770	Lognormal	5,296	5,296		2,150	[CEB][ANOVA]
Chromium	µg/g	27 / 45	27 / 45	60%	16	265	9.7	127	30	28	Lognormal	35	35		46	[CEB][ANOVA]
Cobalt	µg/g	21 / 45	21 / 45	47%	1.4	2.5	3.8	12	4.1	3.6	Lognormal	5.8	5.8		19	[bk]
Copper	µg/g	44 / 45	44 / 45	98%	3.4	3.4	4.7	61	15	12	Lognormal	19	19		42	[CEB][ANOVA]
Iron	µg/g	47 / 47	46 / 46	100%	--	--	7,700	190,000	38,768	31,957	Lognormal	48,174	48,174		46,260	[CEB][ANOVA]
Lead	µg/g	34 / 47	33 / 46	72%	10.0	10.0	13	69	24	18	Lognormal	35	35		35	[CEB][ANOVA]
Magnesium	µg/g	44 / 45	44 / 45	98%	100	100	204	6,110	827	895	Lognormal	1,009	1,009		1,814	[CEB][ANOVA]
Manganese	µg/g	45 / 45	45 / 45	100%	--	--	26	8,100	914	1,304	Lognormal	1,536	1,536		1,664	[CEB][ANOVA]
Mercury	µg/g	10 / 47	9 / 46	20%	0.050	0.087	0.075	0.33	0.062	0.051	Lognormal	0.068	0.068		--	[CEB]
Molybdenum	µg/g	6 / 42	6 / 42	14%	4.0	4.0	5.0	21	3.6	4.5	Lognormal	3.9	3.9		--	[CEB]
Nickel	µg/g	18 / 45	18 / 45	40%	7.5	7.5	3.0	34	8.9	8.2	Lognormal	11	11		23	[CEB][ANOVA]
Potassium	µg/g	44 / 45	44 / 45	98%	142	142	237	2,220	630	425	Lognormal	759	759		1,293	[CEB][ANOVA]
Selenium	µg/g	3 / 45	3 / 45	7%	12	12	1.1	1.8	5.9	1.2	Lognormal	6.7	1.8	#	--	[CEB]
Sodium	µg/g	9 / 45	9 / 45	20%	50	50	72	700	79	154	Lognormal	81	81		197	[CEB][ANOVA]
Thallium	µg/g	3 / 45	3 / 45	7%	13	13	0.44	0.67	5.9	1.4	Lognormal	7.7	0.67	#	--	[CEB]
Vanadium	µg/g	45 / 45	45 / 45	100%	--	--	24	324	68	53	Lognormal	78	78		78	[CEB]
Zinc	µg/g	32 / 45	32 / 45	71%	23	83	19	1,030	77	153	Lognormal	87	87		186	[CEB][ANOVA]
2,4-Dinitrotoluene	µg/g	10 / 45	10 / 45	22%	0.054	0.16	0.065	5.4	0.23	0.83	Lognormal	0.17	0.17		--	[CEB]
2,6-Dinitrotoluene	µg/g	1 / 45	1 / 45	2%	0.079	0.080	0.52	0.52	0.051	0.071	Lognormal	0.051	0.051		--	[CEB]
Acetone	µg/g	3 / 43	3 / 43	7%	0.022	0.12	0.022	0.36	0.032	0.052	Lognormal	0.032	0.032		--	[CEB]
Benzo(b)fluoranthene	µg/g	1 / 34	1 / 34	3%	0.73	0.73	0.56	0.56	0.37	0.033	Lognormal	0.42	0.42		--	[CEB]
Benzo(k)fluoranthene	µg/g	2 / 34	2 / 34	6%	0.40	0.40	0.25	1.4	0.24	0.21	Lognormal	0.25	0.25		--	[CEB]
Benzoic Acid	µg/g	3 / 34	3 / 34	9%	0.92	0.92	4.5	7.7	0.97	1.7	Lognormal	1.0	1.0		--	[CEB]
Carbon Disulfide	µg/g	1 / 43	1 / 43	2%	0.014	0.014	0.032	0.032	0.0076	0.0038	Lognormal	0.0079	0.0079		--	[CEB]
Chrysene	µg/g	1 / 34	1 / 34	3%	0.27	0.27	0.34	0.34	0.14	0.035	Lognormal	0.15	0.15		--	[CEB]
Fluoranthene	µg/g	1 / 34	1 / 34	3%	0.17	0.17	1.3	1.3	0.12	0.21	Lognormal	0.12	0.12		--	[CEB]
Indeno(1,2,3-cd)pyrene	µg/g	1 / 34	1 / 34	3%	0.17	0.17	0.16	0.16	0.087	0.013	Lognormal	0.090	0.090		--	[CEB]
Methylene Chloride	µg/g	4 / 43	4 / 43	9%	0.0042	0.026	0.0040	0.027	0.0049	0.0046	Lognormal	0.0054	0.0054		--	[CEB]
Methylethylketone	µg/g	6 / 43	6 / 43	14%	0.0026	0.0051	0.0020	0.044	0.0039	0.0066	Lognormal	0.0039	0.0039		--	[CEB]
N-Nitrosodiphenylamine	µg/g	1 / 34	1 / 34	3%	0.17	0.17	0.49	0.49	0.097	0.069	Lognormal	0.10	0.10		--	[CEB]
Phenanthrene	µg/g	1 / 34	1 / 34	3%	0.17	0.17	0.30	0.30	0.091	0.037	Lognormal	0.096	0.096		--	[CEB]
Toluene	µg/g	18 / 43	18 / 43	42%	0.0025	0.0025	0.0028	0.035	0.0070	0.0098	Lognormal	0.011	0.011		--	[CEB]
Total Organic Carbon	µg/g	41 / 42	41 / 42	98%	1000	1000	1,560	140,000	35,824	31,000	Lognormal	72,254	72,254		--	[CEB]
bis(2-Ethylhexyl)phthalate	µg/g	2 / 34	2 / 34	6%	0.19	0.19	0.20	0.88	0.12	0.14	Lognormal	0.13	0.13		--	[CEB]

Table 4-93. Summary Statistics and Exposure Point Concentrations for Sediment at Study Area 26 - Crossover Ditch (Continued)
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:26:43 PM
Run Date: 3/29/99
Exposure Unit: 26_DS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]	2 x BK Mean[d]	Background Comparison[g]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

provides the summary statistics for the sediments collected from the Crossover Ditch. The data summary tables are provided in Appendix K. **Figure 4-53** shows the general contaminant group CEBs detected in the sediment samples collected from Study Area 26.

Metals—Twenty-one metals exceeded background concentrations in sediments within the Crossover Ditch, as shown in the adjacent box. The highest CEB metals concentrations were detected at transect locations SD-26-140 (six metals), SD-26-320 (three metals), SD-26-480 (one metal), and SD-26-710 (eight metals), and sample locations SD-27-035 (one metal) and SD-27-036 (two metals). The transects are located north of the Red Water Ditch (SD-26-140) in the vicinity of Study Area 20 (SD-26-320, SD-26-480) and on the Alliance property (formerly ALAAP property) (SD-26-710). The maximum concentrations of arsenic, vanadium, and cadmium were detected in sample SD-26-710C. Mercury and molybdenum were detected at maximum concentrations in SD-26-320B. Samples SD-27-035 and SD-27-036 contained maximum concentrations of selenium and thallium, respectively.

Maximum Concentrations*	
Analyte	**µg/g**
Aluminum	42,000
Arsenic	**370**
Barium	637
Beryllium	3.8
Cadmium	**2.84**
Calcium	44,000
Chromium	127
Copper	60.6
Iron	190,000
Lead	69.1
Manganese	8,100
Magnesium	2,560
Mercury	**0.334**
Molybdenum	**21.3**
Nickel	33.5
Potassium	2,220
Selenium	**1.77**
Sodium	700
Thallium	**0.674**
Vanadium	**324**
Zinc	1,030

*Metals also determined to exceed background based on ANOVA evaluation are shown in bold.

Explosives—In the 396 samples collected from the Crossover Ditch, the average concentration of TNT was 3.2 µg/g, and the maximum concentration was 22.1 µg/g. Explosives were detected in confirmatory samples at transects SD-26-270, SD-26-320, and SD-26-480 in the vicinity of Study Area 20, in transect SD-26-710 on the Alliance property, and in downgradient transect SD-26-080 located north of the Red Water Ditch. 2,4-DNT (0.0645 to 5.38 µg/g) and 2,6-DNT (0.518 µg/g) were the only explosives detected in the sediments, with the maximum concentrations detected at location SD-26-080D (see Sheet 4-12).

Maximum Concentrations	
Analyte	**µg/g**
2,4-DNT	5.38
2,6-DNT	0.518

VOCs—Acetone (0.022 to 0.36 µg/g), carbon disulfide (0.032 µg/g), methylene chloride (0.004 to 0.027 µg/g), and more widely distributed concentrations of MEK (0.002 to 0.044 µg/g) and toluene (0.0028 to 0.035 µg/g) were detected in the sediment samples from Study Area 26. Many of the detected VOC concentrations were near or below the

Maximum Concentrations	
Analyte	**µg/g**
Acetone	0.36
Carbon disulfide	0.032
Methylene Chloride	0.027
MEK	0.044
Toluene	0.035

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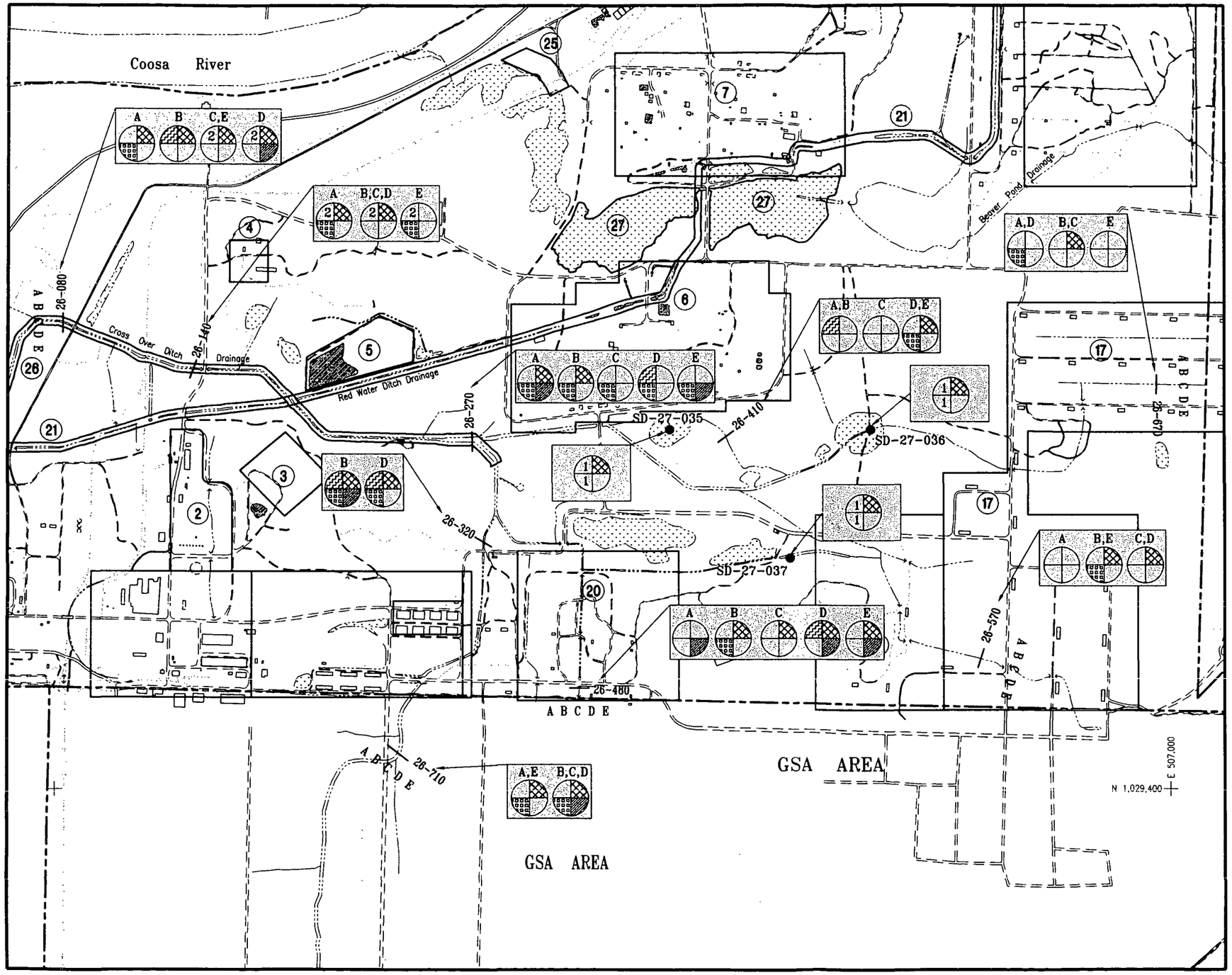


LEGEND:

- BUILDINGS
- PRIMARY ROADS
- SECONDARY ROADS
- AREA BOUNDARIES
- STUDY AREAS
- RAIL ROAD
- CREEK, TRIBUTARIES AND RIVER
- WETLANDS
- PONDS, IMPOUNDMENTS
- GRID BASED ON ALABAMA STATE PLANE EAST
- SEDIMENT SAMPLE TRANSECTS (TYPICAL) STREAM FLOW UP RIVER
- CONFIRMATION SEDIMENT SAMPLE LOCATION
- SEDIMENT CONFIRMATION SAMPLE

ANALYTICAL GROUPS
SVOCs METALS
VOCs EXPLOSIVES

NOTES:

1. CONTAMINANT GROUP NOT ANALYZED AT THIS LOCATION
2. LABORATORY ANALYTICAL DATA FOR THIS CONTAMINATE GROUP WAS REJECTED

0 500 1000 2000
SCALE: 1" = 1000'
STATE PLANE GRID

U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

CEBs in Sediment at Study Area 26

Figure No.	Project No.	File Name	Date
4-53	01-0827-03-8178-045	99015\DWGS\E42PIE14	03-31-99

CRL. The highest concentrations of VOCs were detected at transects SD-26-270 and SD-26-320, located on a tributary of the Crossover Ditch that drains Study Areas 2 and 20, transect SD-26-670 draining Study Area 17, and transect SD-26-710 on the Alliance property.

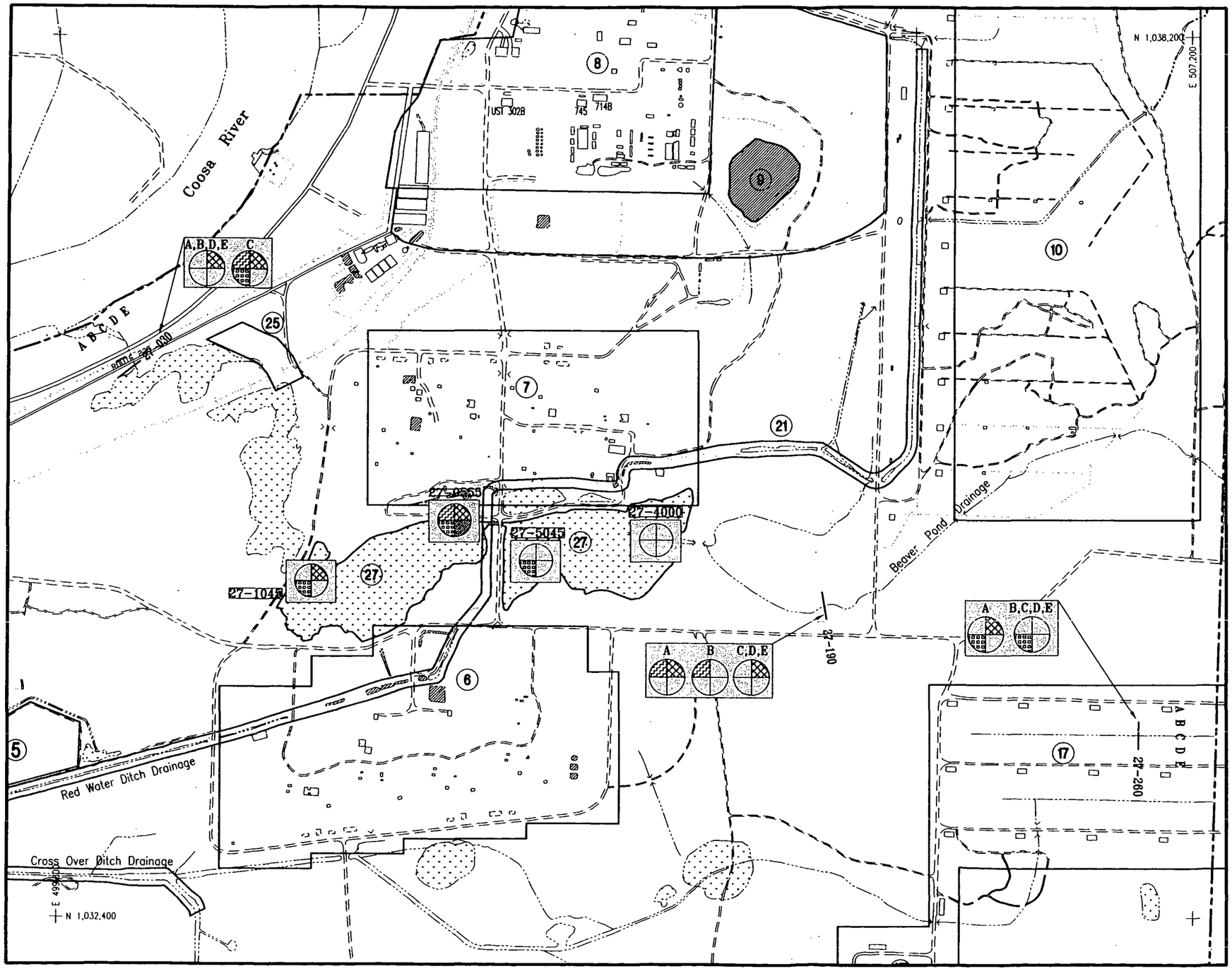
SVOCs—SVOCs detected in the Crossover Ditch sediments included PAHs, benzoic acid, N-Nitrosodiphenylamine (0.49 µg/g), and B2EHP. Isolated concentrations of the PAHs benzo(b)-fluoranthene, benzo(k)fluoranthene, chrysene, fluoranthene, indeno(123-cd)pyrene, and phenanthrene were detected at transects SD-26-320, SD-26-410, and SD-26-480. Benzoic acid (4.5 to 7.7 µg/g) and B2EHP (0.2 and 0.88 µg/g) were variably detected at transects SD-26-270, SD-26-320, and SD-26-410

Maximum Concentrations	
Analyte	**µg/g**
Benzoic Acid	7.7
Benzo(b)fluoranthene	0.56
Benzo(k)fluoranthene	1.4
B2EHP	0.88
Chrysene	0.34
Fluoranthene	1.3
Indeno(123-cd)pyrene	0.16
N-Nitrosodiphenylamine	0.49
Phenanthrene	0.3

Summary—Twenty-one metals, two explosives, five VOCs, and nine SVOCs exceeded background in the sediment samples from Study Area 21. The highest CEB metals concentrations were detected at transect and sample locations SD-26-140, SD-26-320, SD-26-480, SD-26-710, SD-27-035, and SD-27-036. Two explosives, 2,4-DNT and 2,6-DNT, were detected in 10 and 1 of the sediment samples, respectively. All explosives concentrations were less than 5.5 µg/g. The highest concentrations of VOCs were detected at transects SD-26-270, SD-26-320, SD-26-670, and SD-26-710, although many of the detected VOC concentrations were low (near or below the CRL). Six of the nine detected SVOCs were PAHs that were each detected in one or two samples from transects SD-26-320, SD-26-410, and SD-26-480. Benzoic acid, B2EHP, and N-Nitrosodiphenylamine were detected in three, two, and one sample, respectively.

4.7.8 Study Area 27 – Beaver Pond Drainage System

A total of 135 sediment samples were collected from 28 transects along the Beaver Pond Drainage System located between Study Area 17 and the Coosa River during Phase 1 of the Supplemental RI (see Sheet 3-2). The samples were field-screened for explosives, and subsurface samples were collected in 1-foot increments from three locations to 5 feet BLS. Fifteen samples, five from each of three transects, were collected along Study Area 27 for laboratory confirmatory analysis. Transect SD-27-030 was the most downstream location near the Coosa River, and transect SD-27-190 was obtained from drainage located east of the east and west Beaver Ponds. Sample SD-27-260 was collected from a ditch within Study Area 17. Four additional sediment samples were collected: two each from the east (SD-27-4000 and SD-27-5045) and west (SD-27-0555 and SD-27-1045) Beaver Ponds. **Figure 4-54** shows the locations where general contaminant group CEBs were detected in the Study Area 27 sediments. Confirmatory samples were analyzed for metals, explosives, VOCs, and SVOCs. Four of the samples were analyzed for



LEGEND:

- BUILDINGS
- PRIMARY ROADS
- SECONDARY ROADS
- AREA BOUNDARIES
- (27) STUDY AREAS
- RAIL ROAD
- CREEK, TRIBUTARIES AND RIVER
- WETLANDS
- PONDS, IMPOUNDMENTS
- GRID BASED ON ALABAMA STATE PLANE EAST
- A B C D E — SEDIMENT SAMPLE TRANSECTS (TYPICAL) STREAM FLOW UP RIVER
- SEDIMENT CONFIRMATION SAMPLE

ANALYTICAL GROUPS
SVOCs METALS
VOCs EXPLOSIVES

STATE PLANE GRID

0 350 700 1400
SCALE: 1" = 700'

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CHILDERSBURG, ALABAMA

CEBs in Sediment at Study Area 27

Figure No.	Project No.	File Name	Date
4-54	01-0827-03-8178-045	99015\DWGS\E42PIE15	03-31-99

hexavalent chromium. During Phase 2 of the Supplemental RI, one additional sediment sample was collected from SD-27-030C and analyzed for metals. **Table 4-94** provides the summary statistics for this study area. Data summary tables are provided in Appendix K.

Metals—Fifteen metals exceeded background in the Study Area 27 sediment samples, as shown in the adjacent box. Metals concentrations exceeded background in samples from all transect locations except the east Beaver Pond (SD-27-4000 and SD-27-5045). Twelve of these metals were detected at maximum concentrations in samples from transect SD-27-030. Cadmium was detected only in sample SD-27-030D. Mercury was detected in 9 of the 20 sediment samples, with the maximum concentration detected in SD-27-030B, near the Coosa River.

Maximum Concentrations*	
Analyte	µg/g
Aluminum	29,000
Arsenic	33.7
Barium	1,050
Beryllium	1.75
Cadmium	**1.01**
Calcium	5,500
Chromium	62.8
Cobalt	34.4
Iron	51,000
Lead	153
Magnesium	**2,540**
Manganese	7,100
Mercury	**1.2**
Potassium	1,500
Zinc	1,750

*Metals also determined to exceed background based on ANOVA evaluation are shown in bold.

Explosives—A total of 155 sediment samples were collected and screened in the field for explosives. The average TNT concentration was 3.8 µg/g and the maximum was 41.8 µg/g, detected at location SD-27-150C. In the confirmatory samples, an isolated concentration of the nontarget explosive HMX (0.215 µg/g) was detected in sample SD-27-0555 from the west Beaver Pond.

VOCs—MEK (0.0024 to 0.0067 µg/g) was detected in the east and west Beaver Pond sediment samples at locations SD-27-5045, SD-27-0555, SD-27-1045, and SD-27-030 (near the Coosa River). All four detected MEK concentrations were near or below the CRL. Toluene (0.006 to 0.021 µg/g) was detected in four sediment samples collected from transect SD-27-260 (Study Area 17).

Maximum Concentrations	
Analyte	µg/g
MEK	0.0067
Toluene	0.021

SVOCs—SVOCs were detected in sediment samples from three transect locations (SD-27-190, SD-27-0555, and SD-27-030). The PAHs benzo(a)-anthracene, benzo(a)pyrene, and indeno(1,2,3-cd)-pyrene were detected in sample SD-27-0555 in the west Beaver Pond. Benzoic acid (4.6 and 9.3 µg/g) was detected in samples from transect SD-27-190, located east of the Beaver Ponds. An isolated concentration of B2EHP (0.38 µg/g) was detected in sample SD-27-030C.

Maximum Concentrations	
Analyte	µg/g
Benzo(a)anthracene	0.13
Benzo(a)pyrene	0.18
Indeno(1,2,3-cd)pyrene	0.13
Benzoic acid	9.3
B2EHP	0.38

Table 4-94. Summary Statistics and Exposure Point Concentrations for Sediment at Study Area 27 - Beaver Pond Drainage System
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:35:00 PM
Run Date: 3/29/99
Exposure Unit: 27_DS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]	2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	20 / 20	19 / 19	100%	--	--	7,400	29,000	16,225	5,780	Normal	18,524	18,524	25,323	[CEB][ANOVA]
Arsenic	µg/g	6 / 20	6 / 19	32%	13	13	17	34	11	7.0	Lognormal	14	14	15	[CEB][ANOVA]
Barium	µg/g	19 / 19	19 / 19	100%	--	--	58	1,050	165	220	Lognormal	209	209	151	[CEB][ANOVA]
Beryllium	µg/g	18 / 19	18 / 19	95%	0.25	0.25	0.39	1.8	0.80	0.42	Normal	0.96	0.96	1.5	[CEB][ANOVA]
Cadmium	µg/g	1 / 19	1 / 19	5%	0.43	0.43	1.0	1.0	0.26	0.18	Lognormal	0.29	0.29	--	[CEB]
Calcium	µg/g	19 / 19	19 / 19	100%	--	--	245	5,500	1,485	1,615	Lognormal	2,509	2,509	2,150	[CEB][ANOVA]
Chromium	µg/g	19 / 19	19 / 19	100%	--	--	20	63	33	14	Lognormal	40	40	46	[CEB][ANOVA]
Cobalt	µg/g	14 / 19	14 / 19	74%	2.5	2.5	3.0	34	6.0	7.4	Lognormal	9.8	9.8	19	[CEB][ANOVA]
Copper	µg/g	18 / 19	18 / 19	95%	3.4	3.4	5.1	35	13	8.7	Lognormal	20	20	42	[bk]
Iron	µg/g	20 / 20	19 / 19	100%	--	--	13,000	51,000	27,095	10,773	Normal	31,381	31,381	46,260	[CEB][ANOVA]
Lead	µg/g	18 / 20	18 / 19	95%	10.0	10.0	12	153	36	34	Lognormal	55	55	35	[CEB][ANOVA]
Magnesium	µg/g	19 / 19	19 / 19	100%	--	--	213	2,540	833	635	Lognormal	1,153	1,153	1,814	[CEB][ANOVA]
Manganese	µg/g	19 / 19	19 / 19	100%	--	--	280	7,100	1,282	1,498	Lognormal	1,735	1,735	1,664	[CEB][ANOVA]
Mercury	µg/g	9 / 20	8 / 19	42%	0.087	0.087	0.11	1.2	0.20	0.32	Lognormal	0.36	0.36	--	[CEB]
Nickel	µg/g	10 / 19	10 / 19	53%	7.5	7.5	9.5	23	9.9	6.6	Lognormal	15	15	23	[bk]
Potassium	µg/g	19 / 19	19 / 19	100%	--	--	233	1,500	677	350	Lognormal	848	848	1,293	[CEB][ANOVA]
Sodium	µg/g	2 / 19	2 / 19	11%	50	50	83	102	32	21	Lognormal	38	38	197	[bk]
Vanadium	µg/g	19 / 19	19 / 19	100%	--	--	26	69	43	12	Normal	48	48	78	[bk]
Zinc	µg/g	19 / 19	19 / 19	100%	--	--	25	1,750	265	479	Lognormal	612	612	186	[CEB][ANOVA]
Benzo(a)anthracene	µg/g	1 / 19	1 / 19	5%	0.17	0.17	0.13	0.13	0.087	0.010	Lognormal	0.092	0.092	--	[CEB]
Benzo(a)pyrene	µg/g	1 / 19	1 / 19	5%	0.24	0.24	0.18	0.18	0.12	0.014	Lognormal	0.13	0.13	--	[CEB]
Benzoic Acid	µg/g	2 / 19	2 / 19	11%	0.92	0.92	4.6	9.3	1.1	2.2	Lognormal	1.4	1.4	--	[CEB]
Cyclotetramethylenetetranitramine	µg/g	1 / 19	1 / 19	5%	0.16	0.16	0.22	0.22	0.087	0.031	Lognormal	0.095	0.095	--	[CEB]
Indeno(1,2,3-cd)pyrene	µg/g	1 / 19	1 / 19	5%	0.17	0.17	0.13	0.13	0.087	0.010	Lognormal	0.092	0.092	--	[CEB]
Methylethylketone	µg/g	4 / 19	4 / 19	21%	0.0051	0.0051	0.0024	0.0067	0.0029	0.0011	Lognormal	0.0032	0.0032	--	[CEB]
Toluene	µg/g	4 / 19	4 / 19	21%	0.0025	0.0025	0.0060	0.021	0.0034	0.0050	Lognormal	0.0049	0.0049	--	[CEB]
Total Organic Carbon	µg/g	19 / 19	19 / 19	100%	--	--	1,840	56,400	27,925	15,796	Normal	34,209	34,209	--	[CEB]
bis(2-Ethylhexyl)phthalate	µg/g	1 / 19	1 / 19	5%	0.19	0.19	0.38	0.38	0.11	0.065	Lognormal	0.12	0.12	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Summary—Fifteen metals, one nontarget explosive, two VOCs, and five SVOCs were detected in samples from Study Area 27. Most of the maximum metals concentrations were detected in samples from transect SD-27-030 near the Coosa River. HMX was detected in one sample (SD-27-0555) from the west Beaver Pond. MEK was detected in four samples at low (near or below the CRL) concentrations. SVOCs, three of which are PAHs, were detected in samples from three transect locations (SD-27-190, SD-27-0555, and SD-27-030).

4.7.9 Talladega Creek and Tributaries

One hundred sediment samples were collected from two tributaries of Talladega Creek and from the creek itself, and screened for explosives during Phase 1 of the Supplemental RI. The locations of samples collected for field screening are shown on Sheet 3-2. Eleven samples were collected for laboratory confirmatory analysis, including samples at the confluence of Talladega Creek with the Coosa River (SD-TA-160) and the outfall of the tributary draining Study Areas 16 and 19 (SD-TA-110), five samples along a tributary draining Study Areas 16 and 19 (SD-TA-210), and four samples along the tributary draining Study Area 22 (SD-TA-010). These samples were analyzed for metals, explosives, VOCs, and SVOCs. **Figure 4-55** shows the locations where the general contaminant group CEBs were present in the Talladega Creek sediments. **Table 4-95** provides the summary statistics for the analytical results, and Appendix K presents the data summary tables.

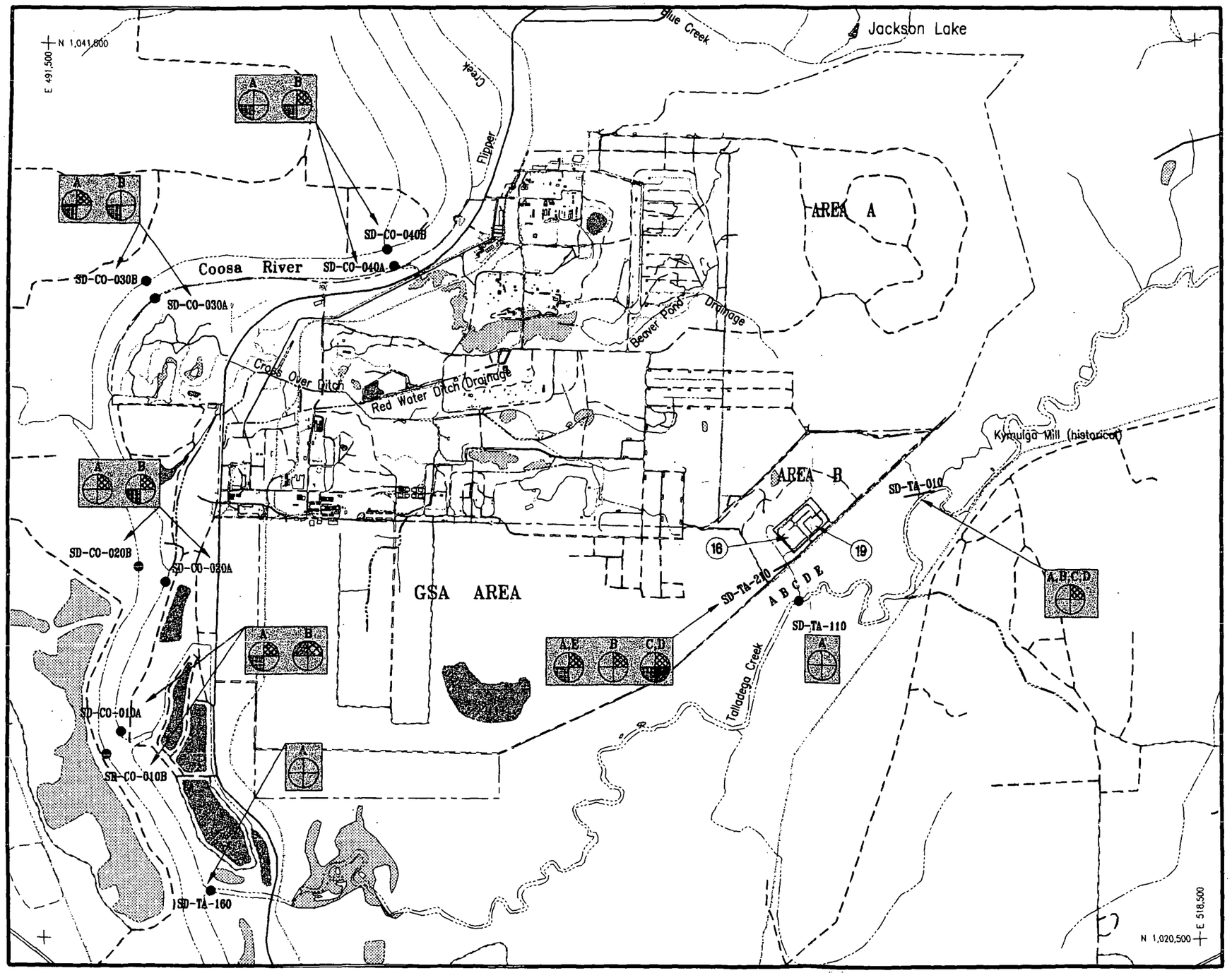
Metals—Eight metals exceeded background in the Talladega Creek sediment samples, as shown in the adjacent box. The maximum metals concentrations were detected in samples from the tributary draining Study Areas 16 and 19 and the tributary draining Study Area 22. The maximum mercury concentration was detected in sample SD-TA-010A, from the Study Area 22 tributary.

Maximum Concentrations*	
Analyte	µg/g
Arsenic	21.5
Barium	279
Beryllium	1.84
Calcium	4.040
Cobalt	18.9
Lead	119
Manganese	2,400
Mercury	**0.134**

*Metals also determined to exceed background based on ANOVA evaluation are shown in bold.

Explosives—During the field screening of 100 sediment samples from the Talladega Creek drainage, a maximum TNT concentration of 14.4 µg/g was detected in sample SD-TA-270C, and the mean concentration was 3.6 µg/g. Laboratory confirmatory results verified that explosives contamination of the Talladega Creek sediments is limited. Isolated concentrations of TNT (0.194 and 0.696 µg/g) and 2,4-DNT (0.358 and 0.573 µg/g) were detected at two locations ("C" and "D") along transect SD-TA-210 from the Study Area 16 and 19 drainage.

Maximum Concentrations	
Analyte	µg/g
TNT	0.696
2,4-DNT	0.573



LEGEND:

- BUILDINGS
- PRIMARY ROADS
- SECONDARY ROADS
- TRAILS
- FENCE
- AREA BOUNDARIES
- STUDY AREAS
- RAIL ROAD
- CREEK, TRIBUTARIES AND RIVER
- WETLANDS
- PONDS, IMPOUNDMENTS
- GRID BASED ON ALABAMA STATE PLANE EAST
- SEDIMENT SAMPLE TRANSECTS (TYPICAL) STREAM FLOW UP RIVER
- SEDIMENT CONFIRMATION SAMPLE

ANALYTICAL GROUPS
SVOCs, VOCs, METALS, EXPLOSIVES

0 1250 2500 5000
SCALE: 1" = 2500'
STATE PLANE GRID

U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

CEBs in Sediment from
Coosa River and Talladega Creek

Figure No.	Project No.	File Name	Date
4-55	01-0827-03-8178-045	99015\DWGS\E42PIE16	03-31-99

Table 4-95. Summary Statistics and Exposure Point Concentrations for Sediment at Talladega Creek
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:12:29 PM
Run Date: 3/29/99
Exposure Unit: TA_DS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	11 / 11	11 / 11	100%	--	--	2,190	21,000	10,228	5,781	Normal	13,388	13,388		25,323	[bk]
Arsenic	µg/g	3 / 11	3 / 11	27%	13	13	15	22	9.9	6.2	Lognormal	14	14		15	[CEB][ANOVA]
Barium	µg/g	11 / 11	11 / 11	100%	--	--	23	279	120	84	Normal	166	166		151	[CEB][ANOVA]
Beryllium	µg/g	8 / 11	8 / 11	73%	0.25	0.25	0.64	1.8	0.91	0.65	Normal	1.3	1.3		1.5	[CEB][ANOVA]
Calcium	µg/g	11 / 11	11 / 11	100%	--	--	211	4,040	1,852	1,333	Normal	2,580	2,580		2,150	[CEB][ANOVA]
Chromium	µg/g	6 / 11	6 / 11	55%	5.8	37	9.0	31	17	11	Normal	23	23		46	[bk]
Cobalt	µg/g	6 / 11	6 / 11	55%	2.5	2.5	3.3	19	6.3	6.7	Lognormal	22	19	#	19	[CEB][ANOVA]
Copper	µg/g	8 / 11	8 / 11	73%	3.4	3.4	17	38	18	13	Normal	25	25		42	[bk]
Iron	µg/g	11 / 11	11 / 11	100%	--	--	4,600	34,000	20,618	10,794	Normal	26,517	26,517		46,260	[bk]
Lead	µg/g	8 / 11	8 / 11	73%	10.0	10.0	28	119	35	32	Lognormal	118	118		35	[CEB][ANOVA]
Magnesium	µg/g	11 / 11	11 / 11	100%	--	--	342	1,530	766	378	Normal	973	973		1,814	[bk]
Manganese	µg/g	11 / 11	11 / 11	100%	--	--	201	2,400	914	778	Lognormal	2,024	2,024		1,664	[CEB][ANOVA]
Mercury	µg/g	3 / 11	3 / 11	27%	0.087	0.087	0.10	0.13	0.063	0.034	Lognormal	0.085	0.085		--	[CEB]
Nickel	µg/g	6 / 11	6 / 11	55%	7.5	7.5	11	19	10	6.4	Lognormal	19	19	#	23	[bk]
Potassium	µg/g	9 / 11	9 / 11	82%	142	142	291	919	534	282	Normal	688	688		1,293	[bk]
Sodium	µg/g	2 / 11	2 / 11	18%	50	50	67	68	33	17	Lognormal	42	42		197	[bk]
Vanadium	µg/g	11 / 11	11 / 11	100%	--	--	6.7	55	36	17	Normal	45	45		78	[bk]
Zinc	µg/g	5 / 11	5 / 11	45%	33	170	30	139	57	35	Normal	76	76		186	[bk]
2,4,6-Trinitrotoluene	µg/g	2 / 11	2 / 11	18%	0.089	0.089	0.19	0.70	0.12	0.20	Lognormal	0.22	0.22		--	[CEB]
2,4-Dinitrotoluene	µg/g	2 / 11	2 / 11	18%	0.056	0.056	0.36	0.57	0.11	0.18	Lognormal	0.28	0.28		--	[CEB]
Toluene	µg/g	4 / 11	4 / 11	36%	0.0025	0.0025	0.0025	0.012	0.0030	0.0034	Lognormal	0.0056	0.0056		--	[CEB]
Total Organic Carbon	µg/g	11 / 11	11 / 11	100%	--	--	1,470	57,000	25,006	16,604	Normal	34,080	34,080		--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.

[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).

[c] CRL - contract reporting limit.

[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).

[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.

[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.

[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.

-- Not applicable (note: background comparison not conducted for organic compounds)

VOCs—Toluene (0.0025 to 0.012 µg/g) was the only VOC detected in the confirmatory samples from Talladega Creek. Toluene was detected in four samples from transect SD-TA-210 from the Study Area 16 and 19 drainage.

SVOCs—SVOCs were not detected in the confirmatory samples from the Talladega Creek drainage.

Summary—Eight metals, two explosives, and one VOC were detected above background in the sediment samples collected from Talladega Creek and its tributaries. Maximum concentrations of three CEB metals, both explosives and toluene, were detected in samples from the tributary draining Study Areas 16 and 19. Maximum concentrations of five CEB metals were detected in sediment samples from the tributary draining Study Area 22.

4.7.10 Coosa River

During Phase 1 of the Supplemental RI, eight samples were collected from four transects along the Coosa River near ALAAP, as shown in Figure 4-55. Samples "A" and "B" were collected from the left and right sides of the channel, respectively, as one looks upstream. Samples were screened for explosives and sent to the laboratory for confirmatory analysis. All samples were analyzed for metals, explosives, VOCs, and SVOCs. Figure 4-55 shows the locations where general contaminant group CEBs were detected in the Coosa River sediments. The summary statistics for detected chemicals are provided in **Table 4-96**. Appendix K provides the data summary tables.

Metals—Eleven metals exceeded background concentrations in sediment samples from the Coosa River, as shown in the adjacent box. Maximum CEB metals concentrations were detected in samples SD-CO-010A and SD-CO-010B near the confluence of Talladega Creek with the Coosa River and at a point of deposition (SD-CO-020B) along the river reach adjacent to the ALAAP facility. Both the maximum barium and mercury concentrations were detected in sample SD-CO-020B.

Maximum Concentrations*	
Analyte	µg/g
Aluminum	32,000
Barium	**509**
Beryllium	1.77
Calcium	9,200
Cobalt	19.6
Copper	54.3
Lead	41.5
Magnesium	4,120
Mercury	**1.2**
Potassium	1,740
Sodium	239

*Metals also determined to exceed background based on ANOVA evaluation are shown in bold

Explosives—An isolated TNT concentration (3.3 µg/g) was detected during field screening. Explosives were not detected in the laboratory confirmatory samples.

Table 4-96. Summary Statistics and Exposure Point Concentrations for Sediment at Study Area CO - Coosa River
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:54:50 PM
Run Date: 3/29/99
Exposure Unit: CO_DS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	8 / 8	8 / 8	100%	--	--	3,250	32,000	14,794	9,119	Normal	20,902	20,902		25,323	[CEB][ANOVA]
Barium	µg/g	8 / 8	8 / 8	100%	--	--	19	509	236	181	Normal	357	357		151	[CEB]
Beryllium	µg/g	7 / 8	7 / 8	88%	0.25	0.25	0.49	1.8	0.81	0.52	Normal	1.2	1.2		1.5	[CEB][ANOVA]
Calcium	µg/g	8 / 8	8 / 8	100%	--	--	451	9,200	2,319	2,945	Lognormal	8,406	8,406		2,150	[CEB][ANOVA]
Cobalt	µg/g	7 / 8	7 / 8	88%	2.5	2.5	5.3	20	9.3	5.7	Normal	13	13		19	[CEB][ANOVA]
Copper	µg/g	7 / 8	7 / 8	88%	3.4	3.4	5.6	54	15	17	Lognormal	65	54	#	42	[CEB][ANOVA]
Iron	µg/g	8 / 8	8 / 8	100%	--	--	10,000	26,000	19,250	6,882	Normal	23,860	23,860		46,260	[bk]
Lead	µg/g	3 / 8	3 / 8	38%	10.0	10.0	32	42	17	16	Lognormal	69	42	#	35	[CEB][ANOVA]
Magnesium	µg/g	8 / 8	8 / 8	100%	--	--	528	4,120	1,733	1,113	Normal	2,478	2,478		1,814	[CEB][ANOVA]
Manganese	µg/g	8 / 8	8 / 8	100%	--	--	160	1,300	493	363	Lognormal	989	989		1,664	[bk]
Mercury	µg/g	3 / 8	3 / 8	38%	0.087	0.087	0.18	1.2	0.30	0.45	Lognormal	3.8	1.2	#	--	[CEB]
Nickel	µg/g	4 / 8	4 / 8	50%	7.5	7.5	14	22	10	7.5	Normal	15	15		23	[bk]
Potassium	µg/g	8 / 8	8 / 8	100%	--	--	344	1,740	925	451	Normal	1,227	1,227		1,293	[CEB][ANOVA]
Sodium	µg/g	4 / 8	4 / 8	50%	50	50	77	239	91	92	Lognormal	351	239	#	197	[CEB][ANOVA]
Vanadium	µg/g	8 / 8	8 / 8	100%	--	--	18	49	31	11	Normal	38	38		78	[bk]
Benzo(a)pyrene	µg/g	1 / 8	1 / 8	13%	0.24	0.24	0.28	0.28	0.14	0.057	Lognormal	0.18	0.18		--	[CEB]
Methylene Chloride	µg/g	3 / 8	3 / 8	38%	0.0062	0.0062	0.0056	0.046	0.0092	0.015	Lognormal	0.025	0.025		--	[CEB]
Methylethylketone	µg/g	5 / 8	5 / 8	63%	0.0051	0.0051	0.0022	0.0081	0.0034	0.0020	Lognormal	0.0050	0.0050		--	[CEB]
Toluene	µg/g	2 / 8	2 / 8	25%	0.0025	0.0025	0.0027	0.0036	0.0017	0.00091	Lognormal	0.0025	0.0025		--	[CEB]
Total Organic Carbon	µg/g	5 / 8	5 / 8	63%	1000	1000	3,150	19,600	5,248	6,382	Lognormal	80,992	19,600	#	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Maximum Concentrations	
Analyte	µg/g
Methylene Chloride	0.046
Toluene	0.0036
MEK	0.0081

VOCs—Three VOCs were detected in the Coosa River sediment samples. Methylene chloride (0.0056 to 0.046 µg/g), MEK (0.0022 to 0.0081 µg/g), and toluene (0.0027 to 0.0036 µg/g) were variably detected at low concentrations within the river sediments. MEK and toluene concentrations were all near or below the CRL. Two of the three methylene chloride detections also were near or below the CRL.

SVOCs—Benzo(a)pyrene (0.28 µg/g) was the only SVOC detected in the Coosa River sediment at SD-CO-010B near the confluence of Talladega Creek with the Coosa River.

Summary—Eleven metals, three VOCs, and one SVOC were detected in the Coosa River sediment samples. Maximum metals concentrations were detected in sample SD-CO-020B and both samples from transect SD-CO-010. The majority of VOC detections were near or below the CRL. Benzo(a)pyrene was detected in only one sample (SD-CO-0108).

4.7.11 Summary of Sediment Results

Sediment samples were collected from streams, ponds, and ditches, including six study areas (Study Areas 5, 9, 16, 21, 26, and 27), Talladega Creek, and the Coosa River. Sediment samples were collected from Fanning and Talladega Creeks to serve as a background comparison. In addition, at Study Area 9, samples were collected from the basin sediment, tar-like material present on a portion of the Aniline Sludge Basin, and the sediment beneath the tar. The chemicals detected in background samples and at concentrations exceeding background in tar samples and sediment samples from all study areas are shown in **Table 4-97**.

At Study Area 9, maximum surface sediment metals concentrations were detected in the sample collected from the north end of the Aniline Sludge Basin. The tar samples from the basin contained 10 metals that exceeded background; the maximum concentrations of these metals were detected in the eastern tar sample. The sediment beneath the tar, which contained eight CEB metals, and the tar had only three common CEB metals.

The Study Area 16 drainage area sediment samples contained only three metals, one of which is a nutrient (sodium), above background concentrations. Study Areas 21, 26, and 27 each contained 15 or more CEB metals.

The Red Water Ditch (Study Area 21) data set contains samples from remediation confirmatory analysis (subsurface sediment) and Supplemental RI analysis. Lead was the only metal analyzed for in the subsurface sediments, and it was a CEB in both the surface and subsurface sediments. The maximum concentrations of 7 of the 17 CEB metals were detected in samples from the northeast end of the ditch.

Table 4-97. Chemicals Exceeding Background in Sediment and Tar Samples Alabama Army Ammunition Plant, Childersburg, Alabama

Chemicals[a]	Study Areas								Talladega	Coosa	Background[b]
	5	9 Basin Sed.	9 Tar	9 Sed. Below Tar	16	21	26	27			
Inorganics											
Aluminum				2		1	1	1		1	1
Antimony				2							
Arsenic		1		2		1	1	1	1		1
Barium						1	1	1	1	1	1
Beryllium						1	1	1	1	1	1
Cadmium							1	1			
Calcium						1	1	1	1	1	1
Chromium		1	1	2		1	1	1			1
Cobalt			1					1	1	1	1
Copper		1	1			1	1			1	1
Iron		1	1	2		1	1	1			1
Lead		1	1			1,2	1	1	1	1	1
Magnesium						1	1	1		1	1
Manganese		1	1			1	1	1	1		1
Mercury				2		1	1	1	1	1	
Molybdenum		1	1			1	1				
Nickel		1	1			1	1				1
Potassium						1	1	1		1	1
Selenium					1		1				
Sodium		1	1	2	1	1	1			1	1
Thallium					1		1				
Vanadium		1		2		1	1				1
Zinc		1	1				1	1			1
Explosives											
1,3,5-TNB						1					
TNT		1				1,2			1		
2,4,-DNT						1	1		1		
2,6-DNT							1				
2-A-4,6-DNT						1					
4-A-2,6-DNT		1				1					
HMX	1							1			
Tetryl						1,2					
VOCs											
Acetone						1	1				1
Benzene			1								
Carbon Disulfide							1				
MEK						1	1	1		1	
Methyl chloride	1						1			1	1
Styrene											
Toluene	1	1				1	1	1	1	1	1
Xylene						1					

[a] A value of 1 indicates that the chemical exceeded background in surface sediments; 2 indicates that the chemical exceeds background in subsurface sediments.
[b] Chemicals that were present in background sediments.

Table 4-97. Chemicals Exceeding Background in Sediment and Tar Samples Alabama Army Ammunition Plant, Childersburg, Alabama (Continued)

Chemicals[a]	Study Areas								Talladega	Coosa	Background[b]
	5	9 Basin Sed.	9 Tar	9 Sed. Below Tar	16	21	26	27			
SVOCs											
Benzo(a)anthracene		1				1		1			1
Benzo(a)pyrene		1				1		1		1	
Benzo(b)fluoranthene		1				1	1				1
Benzo(g,h,i)perylene		1				1					
Benzo(k)fluoranthene		1					1				
Benzoic Acid				1		1	1	1			
bis(2)chloroisopropyl)ether.											1
B2EHP							1	1			
Carbazole			1	1							
Chrysene		1				1	1				1
di-N-butyl phthalate											
Fluoranthene						1	1				1
Indeno(1,2,3-cd)pyrene		1				1	1	1			
N-Nitrosodiphenylamine		1	1	1			1				
Phenanthrene						1	1				1
Phenol			1	1							
Pyrene						1					1

[a] A value of 1 indicates that the chemical exceeded background in surface sediments; 2 indicates that the chemical exceeds background in subsurface sediments.
[b] Chemicals that were present in background sediments.

The Crossover Ditch (Study Area 26) samples contained 22 metals, 21 of which were present at concentrations exceeding background. Maximum metals concentrations were detected in samples from locations on the Alliance property (formerly ALAAP property) and north of the Red Water Ditch.

Metals concentrations exceeded background at all Study Area 27 sample locations except those from the east Beaver Pond. Twelve of the 15 CEB metals were detected at maximum concentrations in samples from the most downstream location near the Coosa River.

In the Talladega Creek and tributaries, maximum CEB metals concentrations were detected in the tributaries that drain Study Areas 16/19 and Study Area 22. Sediment samples collected in the Coosa River near the Talladega Creek confluence and along the river reach adjacent to the Alliance property (formerly ALAAP property) contained maximum CEB metals concentrations.

Target explosives were detected in samples from Study Areas 9, 21, and 26 and the Talladega Creek. One nontarget explosive, HMX, was detected at low (less than 0.5 µg/g) concentrations in one sample each at Study Areas 5 and 27. The highest concentrations and most frequent detections of explosives were in the sediments from Study Area 21, the Red Water Ditch.

The finding is consistent with the use of the ditch to carry process wastewaters. All other sediment explosives concentrations were less than 6 μg/g.

VOCs were detected in samples from Study Areas 5, 9, 21, 26, and 27 and the Talladega Creek and Coosa River. VOCs also were detected in the background sediment samples at concentrations near or below the CRLs. VOC concentrations at Study Area 5 and in many of the samples from other study areas were near or below the CRLs. At Study Area 9, toluene was detected in one surface sediment sample and benzene was detected in both tar samples. Samples from all five transect locations at Study Area 21 contained VOCs, but all concentrations were less than 0.3 μg/g. Although five VOCs were detected in sediments at Study Area 26, concentrations were all less than 0.05 μg/g. At Study Area 27, MEK was detected at concentrations near or below the CRL. Toluene was detected at concentrations less than 0.03 μg/g in Study Area 27 samples at the east end of the drainage system near Study Area 17. Toluene also was detected in four samples from Talladega Creek and its tributaries. All concentrations were less than 0.02 μg/g. Coosa River sediment samples contained three VOCs, all with concentrations less than 0.05 μg/g.

SVOCs, the majority of which are PAHs, were detected in samples from Study Areas 9, 21, 26, and 27 and the Coosa River. Six PAHs and bis(2-chloroisopropyl)ether were detected at concentrations less than 2 μg/g and N-Nitrosodiphenylamine was detected at concentrations as high as 500 μg/g. N-Nitrosodiphenylamine is used in the production of smokeless powder. Comparatively high concentrations of three SVOCs (carbazole, N-Nitrosodiphenylamine, and phenol) were detected in the Study Area 9 tar sample. N-Nitrosodiphenylamine was detected at a maximum concentration of 4,000,000 μg/g in the tar samples. The same three SVOCs detected in the tar samples, as well as benzoic acid, were detected in the sediments beneath the tar. All concentrations in the sediments beneath the tar were several orders of magnitude lower than in the tar samples. Nine PAHs and benzoic acid were detected in the Red Water Ditch sediment samples. The majority of the Study Area 21 SVOC detections were from transects located between Study Areas 7 and 10. Six PAHs, benzoic acid, two phthalates, and N-Nitrosodiphenylamine were detected in sediment samples from the Crossover Ditch. PAH concentrations all were less than 2 μg/g. All phthalate concentrations were less than 31 μg/g. N-Nitrosodiphenylamine was detected in only one sample at 0.49 μg/g. Benzoic acid concentrations all were less than 8 μg/g. Three PAHs, benzoic acid, and B2EHP were detected in sediment samples from three Study Area 27 transect locations. With the exception of benzoic acid (9.3 μg/g), all maximum concentrations were less than 0.4 μg/g. One PAH (benzo[a]pyrene) was the only SVOC detected in the Coosa River sediment samples.

4.8 BIOTA RESULTS

This section presents the results of analysis of animal tissue collected from background locations and the study areas. These data are used to assess the potential for uptake of contaminants from abiotic media into living organisms. The data also are used to assess exposure in the ecological risk assessment (Section 7). Background results are presented in Section 4.8.1. Results

are presented for crayfish (Section 4.8.2), fish (Section 4.8.3), fish fillets (Section 4.8.4), and rabbits (Section 4.8.5).

4.8.1 Background Biota Results

Crayfish, fish, fish fillets, and rabbits were collected from background locations near the ALAAP – Area B boundaries and the tissue was analyzed to assess uptake of chemicals. **Figure 4-56** shows the locations of background biota sampled, sample identifications, and groups of analytes detected in biota tissue. **Tables 4-98** through **4-101** provide summary statistics for each type of background biota tissue result. Data summary tables are provided in Appendix K.

4.8.1.1 Background – Crayfish

Five crayfish samples were collected during Phase 1 of the Supplemental RI from background locations: four crayfish were collected from Talladega Creek above the influence of ALAAP, and one was collected from Fanning Creek (see Figure 4-56). Because two crayfish were small (one from Talladega Creek and one from Fanning Creek), they were composited into a single sample (BC-BK-004) to obtain sufficient tissue for analysis. All samples except one from Talladega Creek (BC-BK-003) were analyzed for metals, explosives, SVOCs, and pesticides/PCBs. The sample from Talladega Creek (BC-BK-003) was analyzed for hexavalent chromium and explosives.

Metals—Sixteen metals were detected in background crayfish tissue. Summary statistics for these metals are presented in Table 4-98. Concentrations of seven of the detected metals were highest in the composite sample (BC-BK-004).

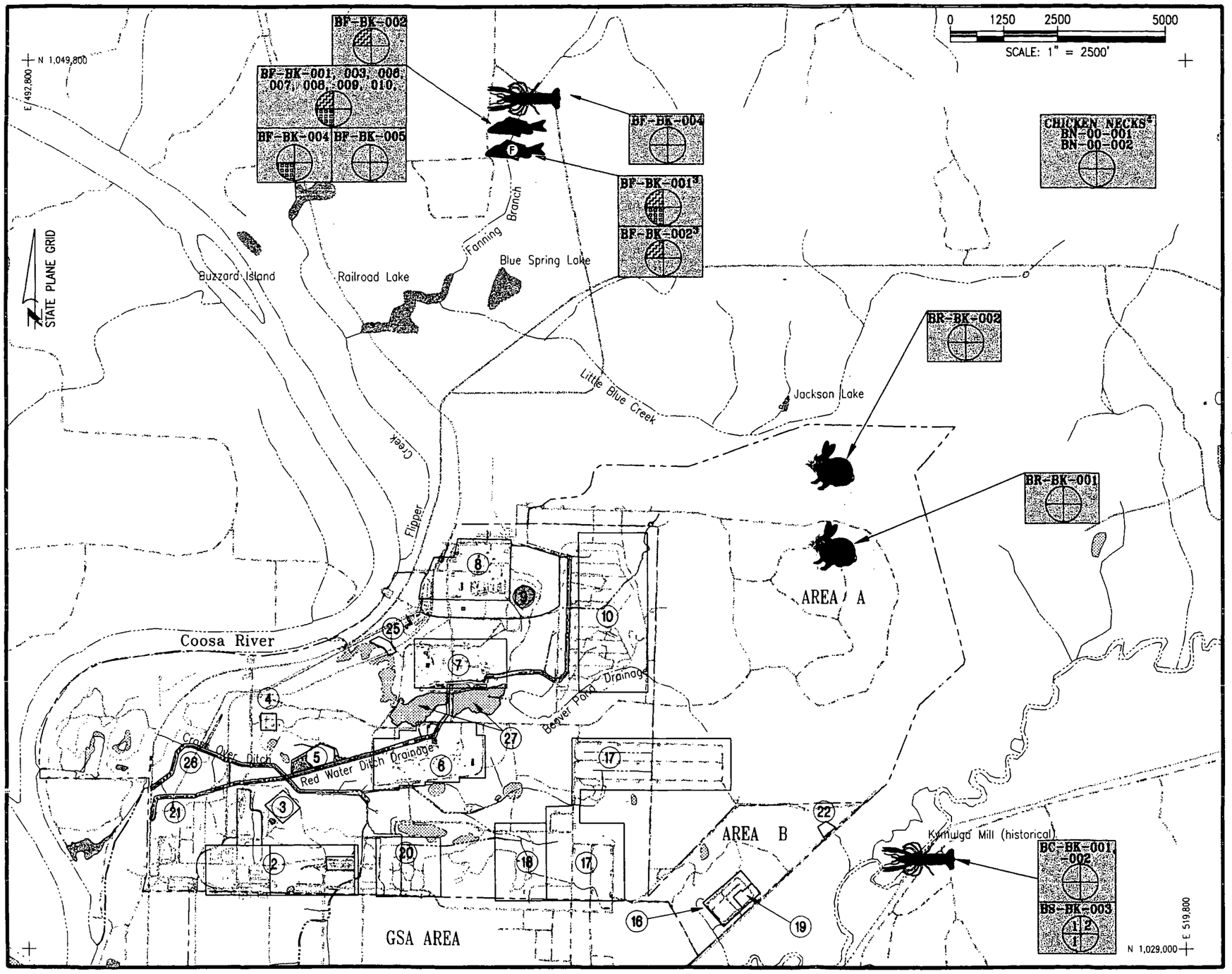
Explosives—Explosives were not detected in any of the crayfish tissue samples obtained from the background locations.

SVOCs—SVOCs were not detected in any of the background crayfish tissue samples analyzed.

Pesticides/PCBs—Pesticides and PCBs were not detected in the background crayfish samples analyzed.

4.8.1.2 Background – Fish

Ten fish, including the two fish fillets discussed in Section 4.8.1.3, were collected from background locations (see Figure 4-56). Samples were analyzed for metals, explosives, SVOCs, and pesticides/PCBs.



LEGEND:

- PRIMARY ROADS
- SECONDARY ROADS
- TRAILS
- AREA BOUNDARIES
- (27) STUDY AREAS
- CREEK, TRIBUTARIES AND RIVER
- WETLANDS
- PONDS, IMPOUNDMENTS
- GRID BASED ON ALABAMA STATE PLANE EAST
- RABBIT COLLECTION LOCATION
- FISH FILLET COLLECTION LOCATION
- FISH COLLECTION LOCATION
- CRAYFISH COLLECTION LOCATION
- BIOTA TISSUE CONFIRMATION SAMPLE

ANALYTICAL GROUPS
SVOCs, METALS, PESTICIDES/PCBs, EXPLOSIVES

NOTE:

1. CONTAMINANT GROUP NOT ANALYZED AT THIS LOCATION
2. METALS ANALYSIS FOR HEXAVALENT CHROMIUM ONLY
3. FISH FROM TWO SAMPLE LOCATIONS BF-BK-001 & BF-BK-002 WERE COLLECTED AND ANALYZED AS WHOLE FISH AND AS FISH FILLETS.
4. CHICKEN NECK RESULTS WERE PRESENTED BECAUSE THESE WERE USED AS BAIT FOR THE CRAYFISH.

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CHILDERSBURG, ALABAMA

Background Biota Tissue Results

Figure No.	Project No.	File Name	Date
4-56	01-0827-03-8178-045	99015\DWGS\E42BIOBK	03-31-99

Table 4-98. Summary Statistics and Exposure Point Concentrations for Crayfish at Study Area BK - Background
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 12:05:03 PM
Run Date: 3/31/99
Exposure Unit: BK_PS3

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	3 / 3	3 / 3	100%	--	--	95	147	113	--	Undetermined	--	147	#	227	--
Antimony	µg/g	1 / 3	1 / 3	33%	0.12	0.15	0.21	0.21	0.12	--	Undetermined	--	0.21	#	0.23	--
Arsenic	µg/g	1 / 3	1 / 3	33%	0.080	0.73	0.100	0.100	0.17	--	Undetermined	--	0.100	#	0.34	--
Barium	µg/g	3 / 3	3 / 3	100%	--	--	37	94	60	--	Undetermined	--	94	#	121	--
Calcium	µg/g	3 / 3	3 / 3	100%	--	--	38,100	51,800	42,900	--	Undetermined	--	51,800	#	85,800	--
Copper	µg/g	2 / 3	2 / 3	67%	9.3	9.3	23	26	18	--	Undetermined	--	26	#	36	--
Iron	µg/g	3 / 3	3 / 3	100%	--	--	105	264	159	--	Undetermined	--	264	#	318	--
Lead	µg/g	2 / 3	2 / 3	67%	0.25	0.25	0.100	0.16	0.13	--	Undetermined	--	0.16	#	0.26	--
Magnesium	µg/g	3 / 3	3 / 3	100%	--	--	594	812	701	--	Undetermined	--	812	#	1,401	--
Manganese	µg/g	3 / 3	3 / 3	100%	--	--	198	880	467	--	Undetermined	--	880	#	933	--
Potassium	µg/g	3 / 3	3 / 3	100%	--	--	1,520	1,690	1,613	--	Undetermined	--	1,690	#	3,227	--
Selenium	µg/g	1 / 3	1 / 3	33%	0.090	0.090	0.090	0.090	0.060	--	Undetermined	--	0.090	#	0.12	--
Silver	µg/g	3 / 3	3 / 3	100%	--	--	0.98	1.4	1.2	--	Undetermined	--	1.4	#	2.3	--
Sodium	µg/g	3 / 3	3 / 3	100%	--	--	1,450	1,560	1,517	--	Undetermined	--	1,560	#	3,033	--
Vanadium	µg/g	1 / 3	1 / 3	33%	0.25	0.40	0.40	0.40	0.24	--	Undetermined	--	0.40	#	0.48	--
Zinc	µg/g	3 / 3	3 / 3	100%	--	--	21	26	23	--	Undetermined	--	26	#	47	--

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-99. Summary Statistics and Exposure Point Concentrations for Fish at Study Area BK - Background
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 12:03:09 PM
Run Date: 3/31/99
Exposure Unit: BK_PS2

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	10 / 10	10 / 10	100%	- -	- -	11	56	26	13	Normal	34	34		52	- -
Antimony	µg/g	9 / 10	9 / 10	90%	0.19	0.19	0.22	1.3	0.74	0.42	Normal	0.98	0.98		1.5	- -
Arsenic	µg/g	4 / 10	4 / 10	40%	0.19	0.30	0.11	0.20	0.13	0.032	Normal	0.15	0.15		0.26	- -
Barium	µg/g	9 / 10	9 / 10	90%	1.2	1.2	1.3	5.8	2.8	1.6	Normal	3.8	3.8		5.7	- -
Calcium	µg/g	10 / 10	10 / 10	100%	- -	- -	6,380	202,000	32,174	59,950	Lognormal	71,161	71,161		64,348	- -
Copper	µg/g	4 / 10	4 / 10	40%	0.84	3.2	1.1	5.7	1.5	1.6	Lognormal	3.1	3.1		3.0	- -
Iron	µg/g	10 / 10	10 / 10	100%	- -	- -	10	63	26	17	Normal	35	35		51	- -
Lead	µg/g	4 / 10	4 / 10	40%	0.100	0.100	0.100	0.21	0.085	0.054	Lognormal	0.13	0.13		0.17	- -
Magnesium	µg/g	10 / 10	10 / 10	100%	- -	- -	323	472	404	52	Normal	434	434		809	- -
Manganese	µg/g	10 / 10	10 / 10	100%	- -	- -	3.1	37	18	11	Normal	24	24		36	- -
Mercury	µg/g	10 / 10	10 / 10	100%	- -	- -	0.060	0.27	0.17	0.064	Normal	0.21	0.21		0.34	- -
Potassium	µg/g	10 / 10	10 / 10	100%	- -	- -	1,920	3,160	2,666	432	Normal	2,916	2,916		5,332	- -
Selenium	µg/g	3 / 10	3 / 10	30%	0.100	2.5	0.100	0.15	0.31	0.49	Lognormal	1.4	0.15	#	0.62	- -
Sodium	µg/g	10 / 10	10 / 10	100%	- -	- -	630	6,100	2,502	1,765	Normal	3,525	3,525		5,004	- -
Vanadium	µg/g	1 / 10	1 / 10	10%	0.38	0.40	0.42	0.42	0.22	0.071	Lognormal	0.25	0.25		0.43	- -
Zinc	µg/g	10 / 10	10 / 10	100%	- -	- -	17	50	28	11	Normal	34	34		56	- -
2,2-bis(p-chlorophenyl)-1,1-dichl	µg/g	8 / 10	8 / 10	80%	0.0033	0.0033	0.0025	0.032	0.0089	0.0092	Lognormal	0.026	0.026		- -	- -
2,2-bis (para-chlorophenyl)-1,1,1-	µg/g	1 / 10	1 / 10	10%	0.0033	0.0033	0.0052	0.0052	0.0020	0.0011	Lognormal	0.0025	0.0025		- -	- -
4-Methyl Phenol	µg/g	4 / 10	4 / 10	40%	0.33	0.66	0.067	0.15	0.16	0.071	Lognormal	0.22	0.15	#	- -	- -
Aldrin	µg/g	1 / 10	1 / 10	10%	0.0017	0.0017	0.0026	0.0026	0.0010	0.00055	Lognormal	0.0013	0.0013		- -	- -
Benzoic Acid	µg/g	4 / 10	4 / 10	40%	1.6	3.2	0.22	0.46	0.69	0.40	Lognormal	1.2	0.46	#	- -	- -
Endrin Aldehyde	µg/g	1 / 10	1 / 10	10%	0.0033	0.0033	0.0035	0.0035	0.0018	0.00059	Lognormal	0.0021	0.0021		- -	- -
beta-BHC	µg/g	1 / 10	1 / 10	10%	0.0017	0.0017	0.0019	0.0019	0.00096	0.00033	Lognormal	0.0011	0.0011		- -	- -
bis(2-Ethylhexyl)phthalate	µg/g	3 / 10	3 / 10	30%	0.15	0.66	0.16	0.72	0.22	0.20	Lognormal	0.40	0.40		- -	- -

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.

[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).

[c] CRL - contract reporting limit.

[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).

[e] *Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal* goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.

[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.

[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.

- - Not applicable (note: background comparison not conducted for organic compounds)

Table 4-100. Summary Statistics and Exposure Point Concentrations for Fish Fillets at Study Area BK - Background
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time 12:06:49 PM
Run Date. 3/31/99
Exposure Unit BK_PS4

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[g]	Background Comparison[h]
Aluminum	µg/g	2 / 2	2 / 2	100%	--	--	11	13	12	--	Undetermined	--	13	#	24	--
Antimony	µg/g	2 / 2	2 / 2	100%	--	--	0.37	0.96	0.67	--	Undetermined	--	0.96	#	1.3	--
Arsenic	µg/g	2 / 2	2 / 2	100%	--	--	0.13	0.20	0.17	--	Undetermined	--	0.20	#	0.33	--
Barium	µg/g	1 / 2	1 / 2	50%	1.2	1.2	1.3	1.3	0.95	--	Undetermined	--	1.3	#	1.9	--
Calcium	µg/g	2 / 2	2 / 2	100%	--	--	6,380	6,960	6,670	--	Undetermined	--	6,960	#	13,340	--
Copper	µg/g	2 / 2	2 / 2	100%	--	--	1.1	5.7	3.4	--	Undetermined	--	5.7	#	6.8	--
Iron	µg/g	2 / 2	2 / 2	100%	--	--	10	14	12	--	Undetermined	--	14	#	24	--
Magnesium	µg/g	2 / 2	2 / 2	100%	--	--	323	345	334	--	Undetermined	--	345	#	668	--
Manganese	µg/g	2 / 2	2 / 2	100%	--	--	3.1	6.0	4.6	--	Undetermined	--	6.0	#	9.1	--
Mercury	µg/g	2 / 2	2 / 2	100%	--	--	0.15	0.27	0.21	--	Undetermined	--	0.27	#	0.42	--
Potassium	µg/g	2 / 2	2 / 2	100%	--	--	3,120	3,160	3,140	--	Undetermined	--	3,160	#	6,280	--
Sodium	µg/g	2 / 2	2 / 2	100%	--	--	630	3,670	2,150	--	Undetermined	--	3,670	#	4,300	--
Zinc	µg/g	2 / 2	2 / 2	100%	--	--	17	26	21	--	Undetermined	--	26	#	42	--
2,2-bis(p-chlorophenyl)-1,1-dichl	µg/g	1 / 2	1 / 2	50%	0.0033	0.0033	0.0043	0.0043	0.0030	--	Undetermined	--	0.0043	#	--	--
bis(2-Ethylhexyl)phthalate	µg/g	2 / 2	2 / 2	100%	--	--	0.16	0.30	0.23	--	Undetermined	--	0.30	#	--	--

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-101. Summary Statistics and Exposure Point Concentrations for Rabbits at Study Area BK - Background
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 12.01:06 PM
Run Date: 3/31/99
Exposure Unit: BK__PS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	2 / 2	2 / 2	100%	--	--	4.4	9.6	7.0	--	Undetermined	--	9.6	#	14	--
Antimony	µg/g	2 / 2	2 / 2	100%	--	--	0.58	0.73	0.66	--	Undetermined	--	0.73	#	1.3	--
Barium	µg/g	1 / 2	1 / 2	50%	1.2	1.2	7.8	7.8	4.2	--	Undetermined	--	7.8	#	8.4	--
Calcium	µg/g	2 / 2	2 / 2	100%	--	--	532	5,560	3,046	--	Undetermined	--	5,560	#	6,092	--
Iron	µg/g	2 / 2	2 / 2	100%	--	--	14	17	15	--	Undetermined	--	17	#	30	--
Lead	µg/g	1 / 2	1 / 2	50%	0.090	0.090	0.15	0.15	0.098	--	Undetermined	--	0.15	#	0.20	--
Magnesium	µg/g	2 / 2	2 / 2	100%	--	--	252	368	310	--	Undetermined	--	368	#	620	--
Nickel	µg/g	2 / 2	2 / 2	100%	--	--	0.94	1.1	1.0	--	Undetermined	--	1.1	#	2.0	--
Potassium	µg/g	2 / 2	2 / 2	100%	--	--	3,780	3,820	3,800	--	Undetermined	--	3,820	#	7,600	--
Sodium	µg/g	2 / 2	2 / 2	100%	--	--	404	590	497	--	Undetermined	--	590	#	994	--
Zinc	µg/g	2 / 2	2 / 2	100%	--	--	8.9	19	14	--	Undetermined	--	19	#	28	--

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Metals—Sixteen metals were detected in background fish samples. Summary statistics for these metals are presented in Table 4-99.

Explosives—Explosives were not detected in any of the background fish samples.

SVOCs—Benzoic acid (0.216 to 0.459 µg/g), 4-methyl phenol (0.0669 to 0.154 µg/g), and B2EHP (0.162 to 0.722 µg/g) were detected in the background fish tissue samples. Of these three SVOCs, only B2EHP was detected at a concentration above the CRL.

Pesticides/PCBs—4,4′-DDE (0.0025 to 0.0320 µg/g), 4,4′-DDT (0.0052 µg/g), aldrin (0.0026 µg/g), beta-BHC (0.0019 µg/g) and endrin aldehyde (0.0035 µg/g) were detected in the background fish samples.

4.8.1.3 Background – Fish Fillets

Two background fish fillets (BF-BK-001 and BF-BK-002) were collected outside Area B and were analyzed for metals, hexavalent chromium, explosives, SVOCs, and pesticides/PCBs.

Metals—Thirteen metals were detected in background fish fillets. Summary statistics for these metals are shown in Table 4-100.

Explosives—Explosives were not detected in either background fish fillet.

SVOCs—One SVOC, B2EHP (0.162 to 0.304 µg/g), was detected in the background fish fillet samples at concentrations below the CRL.

Pesticides/PCBs—4,4′-DDE (0.0043 µg/g) was detected in one (BF-BK-001) of the two background fish fillet samples.

4.8.1.4 Background – Rabbits

Two rabbits were collected outside Area B (see Figure 4-56) and analyzed for metals, explosives, SVOCs, and pesticides/PCBs. One of the rabbits also was analyzed for hexavalent chromium.

Metals—Eleven metals were detected in background rabbits. Summary statistics for these metals are shown in Table 4-101.

Explosives —Explosives were not detected in either of the background rabbit samples.

SVOCs—SVOCs were not detected in either of the background rabbit samples.

Pesticides/PCBs—Pesticides and PCBs were not detected in either of the background rabbit samples.

4.8.1.5 Summary of Background Biota Results

Metals were detected in all the background biota tissue samples. SVOCs and pesticides also were detected in background fish and fish fillet tissues. Explosives were not detected in any of the background tissue samples.

4.8.2 Crayfish

Twenty crayfish were collected from study areas for analysis: 13 from the Crossover Ditch (Study Area 26), 5 from the east Beaver Pond (Study Area 27), and 2 from a Talladega Creek tributary that drains Study Areas 16 and 19. The sampling locations are shown in **Figure 4-57.**

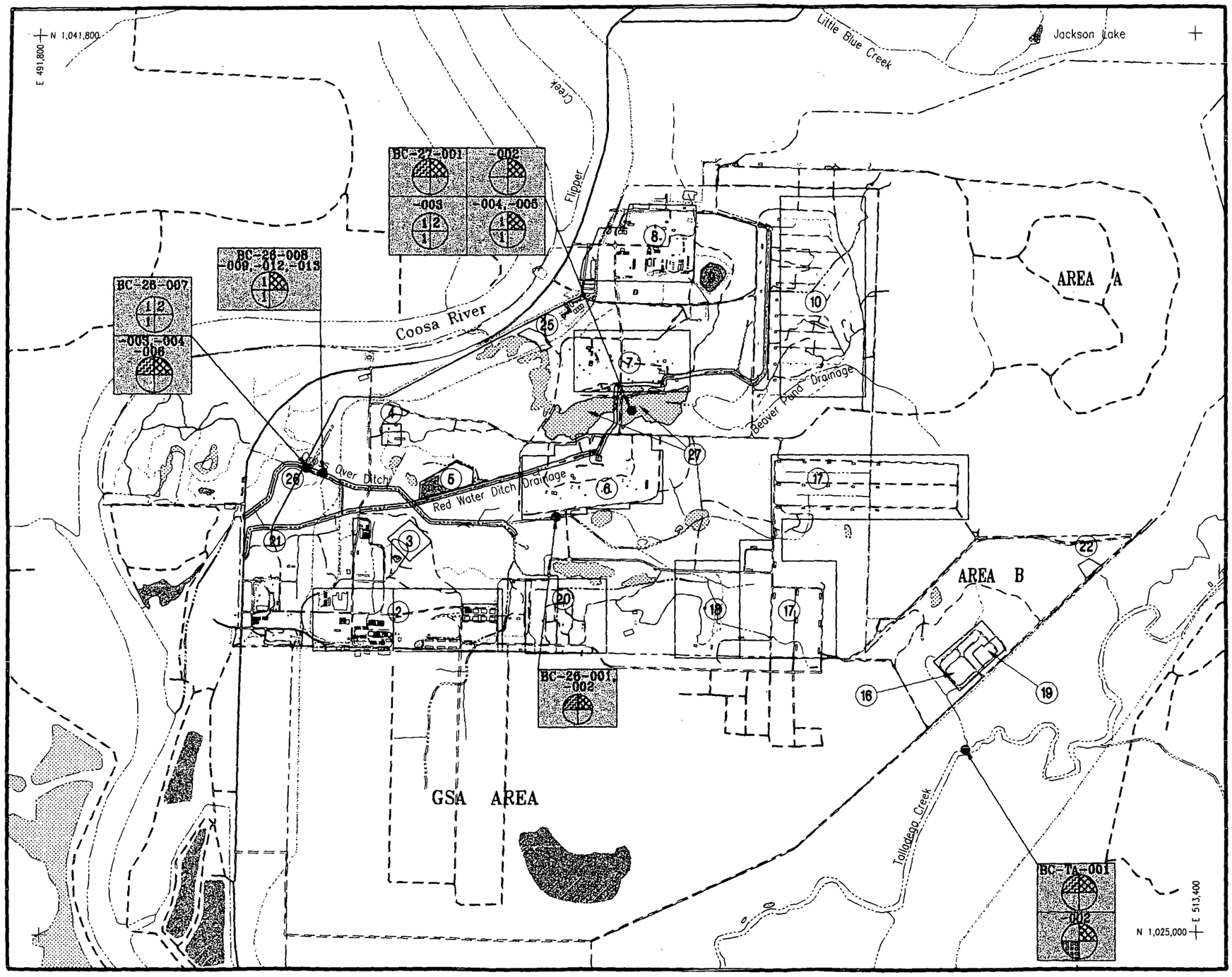
The entire crayfish (i.e., the whole body) was analyzed for some samples, while the tail and remainder of the body were analyzed separately in others. Crayfish tissue samples were analyzed for metals, explosives, SVOCs, and pesticides/PCBs. One crayfish from each of Study Areas 26 and 27 was analyzed for hexavalent chromium. Because chicken necks were used to bait the crayfish traps, two chicken necks also were analyzed as a QC measure. Organic compounds were not detected in the chicken necks (see Appendix K), and metals concentrations were low relative to crayfish metals concentrations. The results indicate that chemicals detected in the crayfish tissue samples did not result from ingestion of chicken necks.

Data summary tables for the individual samples are presented in Appendix K. **Tables 4-102** through **4-104** provide summary statistics for all detected analytes.

Metals—Fourteen metals exceeded background concentrations in crayfish from one or more study areas. These metals and their maximum concentrations are listed in the adjacent box. As shown in the table, higher concentrations of 11 metals (out of 14 metals detected) were detected in crayfish samples from Study Area 26 (Crossover Ditch). The highest concentrations of eight metals were detected in tissue from crayfish collected in the lower end of the Crossover Ditch near the western edge of the site. These crayfish

Maximum Concentrations (mg/g)*			
Analyte	Study Area 26	Study Area 27	Talladega Creek Tributary
Aluminum	530	265	
Antimony	0.65		0.33
Arsenic	1	0.48	
Barium		187	
Chromium	1.2	0.5	
Cobalt	2.0		
Iron	1,000	899	
Lead	1.2	0.3	0.28
Manganese	2,530	2,290	
Mercury	0.13	0.14	
Nickel	2.5		2.5
Potassium	3,820	3,840	
Selenium	0.34	0.3	0.27
Vanadium	1.2		

* ANOVA evaluation not conducted because there are fewer than four samples in the background data set.



LEGEND:

- BUILDINGS
- PRIMARY ROADS
- SECONDARY ROADS
- TRAILS
- FENCE
- AREA BOUNDARIES
- (27) STUDY AREAS
- RAIL ROAD
- CREEK, TRIBUTARIES AND RIVER
- WETLANDS
- PONDS, IMPOUNDMENTS
- GRID BASED ON ALABAMA STATE PLANE EAST
- CRAYFISH COLLECTION LOCATION
- BIOTA TISSUE CONFIRMATION SAMPLE

ANALYTICAL GROUPS
SVOCs METALS
PESTICIDES/PCBs EXPLOSIVES

NOTE:

1. CONTAMINANT GROUP NOT ANALYZED AT THIS LOCATION
2. METALS ANALYSIS FOR HEXAVALENT CHROMIUM ONLY

STATE PLANE GRID

0 1000 2000 4000
SCALE: 1" = 2000'

U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

CEBs in Crayfish Tissue at ALAAP

Figure No.	Project No.	File Name	Date
4-57	01-0827-03-8178-045	99015\DWGS\E42PIE19	03-31-99

Table 4-102. Summary Statistics and Exposure Point Concentrations for Crayfish at Study Area 26 - Crossover Ditch
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:21:34 PM
Run Date: 3/29/99
Exposure Unit: 26__PS3

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	9 / 9	9 / 9	100%	--	--	7.8	530	232	191	Normal	351	351		227	[CEB]
Antimony	µg/g	5 / 9	5 / 9	56%	0.18	0.41	0.21	0.65	0.27	0.19	Normal	0.38	0.38		0.23	[CEB]
Arsenic	µg/g	9 / 9	9 / 9	100%	--	--	0.11	1.00	0.54	0.38	Normal	0.78	0.78		0.34	[CEB]
Barium	µg/g	7 / 9	7 / 9	78%	1.00	1.1	40	112	62	42	Normal	88	88		121	[bk]
Calcium	µg/g	9 / 9	9 / 9	100%	--	--	347	56,600	32,243	19,956	Normal	44,613	44,613		85,800	[bk]
Chromium	µg/g	6 / 9	6 / 9	67%	0.42	0.49	0.50	1.2	0.60	0.36	Normal	0.82	0.82		--	[CEB]
Cobalt	µg/g	2 / 9	2 / 9	22%	0.72	0.88	1.00	2.0	0.65	0.54	Lognormal	1.0	1.0		--	[CEB]
Copper	µg/g	9 / 9	9 / 9	100%	--	--	3.4	22	12	5.9	Normal	16	16		36	[bk]
Iron	µg/g	9 / 9	9 / 9	100%	--	--	22	1000	403	318	Normal	600	600		318	[CEB]
Lead	µg/g	6 / 9	6 / 9	67%	0.090	0.090	0.15	1.2	0.37	0.43	Lognormal	2.6	1.2	#	0.26	[CEB]
Magnesium	µg/g	9 / 9	9 / 9	100%	--	--	331	731	546	144	Normal	635	635		1,401	[bk]
Manganese	µg/g	9 / 9	9 / 9	100%	--	--	6.2	2,530	679	808	Lognormal	83,686	2,530	#	933	[CEB]
Mercury	µg/g	4 / 9	4 / 9	44%	0.040	0.050	0.040	0.13	0.047	0.040	Lognormal	0.088	0.088		--	[CEB]
Nickel	µg/g	2 / 9	2 / 9	22%	0.76	3.7	1.6	2.5	1.2	0.79	Normal	1.7	1.7		--	[CEB]
Potassium	µg/g	9 / 9	9 / 9	100%	--	--	1,110	3,820	2,151	969	Lognormal	2,984	2,984		3,227	[CEB]
Selenium	µg/g	8 / 9	8 / 9	89%	0.080	0.080	0.11	0.34	0.20	0.10	Normal	0.26	0.26		0.12	[CEB]
Silver	µg/g	7 / 9	7 / 9	78%	0.34	0.37	0.74	1.3	0.80	0.39	Normal	1.0	1.0		2.3	[bk]
Sodium	µg/g	9 / 9	9 / 9	100%	--	--	1,230	1,890	1,608	224	Normal	1,747	1,747		3,033	[bk]
Vanadium	µg/g	6 / 9	6 / 9	67%	0.34	0.39	0.37	1.2	0.55	0.38	Normal	0.78	0.78		0.48	[CEB]
Zinc	µg/g	9 / 9	9 / 9	100%	--	--	16	23	19	2.1	Normal	20	20		47	[bk]
4-Methyl Phenol	µg/g	2 / 5	2 / 5	40%	0.66	0.66	0.16	0.34	0.30	0.078	Lognormal	0.46	0.34	#	--	[CEB]
Benzoic Acid	µg/g	3 / 5	3 / 5	60%	3.2	3.2	0.15	0.34	0.78	0.76	Normal	1.5	0.34	#	--	[CEB]
Phenol	µg/g	3 / 5	3 / 5	60%	0.66	0.66	0.26	0.36	0.31	0.045	Normal	0.35	0.35		--	[CEB]
bis(2-Ethylhexyl)phthalate	µg/g	1 / 5	1 / 5	20%	0.17	2.2	0.14	0.14	0.35	0.43	Lognormal	5.8	0.14	#	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-103. Summary Statistics and Exposure Point Concentrations for Crayfish at Study Area 27 - Beaver Pond Drainage System
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:31:15 PM
Run Date: 3/29/99
Exposure Unit: 27_PS3

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	4 / 4	4 / 4	100%	- -	- -	25	265	151	106	Normal	276	265	#	227	[CEB]
Arsenic	µg/g	3 / 4	3 / 4	75%	0.11	0.11	0.43	0.48	0.35	0.20	Lognormal	34	0.48	#	0.34	[CEB]
Barium	µg/g	4 / 4	4 / 4	100%	- -	- -	1.9	187	125	85	Normal	225	187	#	121	[CEB]
Calcium	µg/g	4 / 4	4 / 4	100%	- -	- -	379	59,500	33,495	24,515	Normal	62,342	59,500	#	85,800	[bk]
Chromium	µg/g	2 / 4	2 / 4	50%	0.49	0.50	0.45	0.50	0.36	0.13	Normal	0.52	0.50	#	- -	[CEB]
Copper	µg/g	4 / 4	4 / 4	100%	- -	- -	3.9	11	8.7	3.2	Normal	13	11	#	36	[bk]
Iron	µg/g	4 / 4	4 / 4	100%	- -	- -	72	899	588	358	Normal	1,010	899	#	318	[CEB]
Lead	µg/g	3 / 4	3 / 4	75%	0.11	0.11	0.13	0.30	0.17	0.11	Normal	0.30	0.30		0.26	[CEB]
Magnesium	µg/g	4 / 4	4 / 4	100%	- -	- -	353	771	545	173	Normal	749	749		1,401	[bk]
Manganese	µg/g	4 / 4	4 / 4	100%	- -	- -	46	2,290	1,115	920	Normal	2,198	2,198		933	[CEB]
Mercury	µg/g	3 / 4	3 / 4	75%	0.050	0.050	0.050	0.14	0.069	0.050	Normal	0.13	0.13		- -	[CEB]
Potassium	µg/g	4 / 4	4 / 4	100%	- -	- -	1,480	3,840	2,235	1,082	Lognormal	5,035	3,840	#	3,227	[CEB]
Selenium	µg/g	2 / 4	2 / 4	50%	0.090	0.100	0.080	0.30	0.12	0.12	Lognormal	2.4	0.30	#	0.12	[CEB]
Silver	µg/g	3 / 4	3 / 4	75%	0.40	0.40	0.74	1.4	0.77	0.49	Normal	1.3	1.3		2.3	[bk]
Sodium	µg/g	4 / 4	4 / 4	100%	- -	- -	1,420	1,910	1,720	215	Normal	1,973	1,910	#	3,033	[bk]
Vanadium	µg/g	1 / 4	1 / 4	25%	0.34	0.40	0.41	0.41	0.24	0.11	Lognormal	0.52	0.41	#	0.48	[bk]
Zinc	µg/g	4 / 4	4 / 4	100%	- -	- -	17	23	20	3.0	Normal	24	23	#	47	[bk]
4-Methyl Phenol	µg/g	1 / 2	1 / 2	50%	0.66	0.66	0.14	0.14	- -	- -	Undetermined	- -	0.14	#	- -	[CEB]
Phenol	µg/g	1 / 2	1 / 2	50%	0.66	0.66	0.16	0.16	- -	- -	Undetermined	- -	0.16	#	- -	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
- - Not applicable (note: background comparison not conducted for organic compounds)

Table 4-104. Summary Statistics and Exposure Point Concentrations for Crayfish at Study Area TA - Talladega Creek
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 7:28:50 PM
Run Date: 3/29/99
Exposure Unit: TA__PS3

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[g]	Background Comparison[g]
Aluminum	µg/g	2 / 2	2 / 2	100%	--	--	110	131	--	--	Undetermined	--	131	#	227	[bk]
Antimony	µg/g	2 / 2	2 / 2	100%	--	--	0.20	0.33	--	--	Undetermined	--	0.33	#	0.23	[CEB]
Arsenic	µg/g	2 / 2	2 / 2	100%	--	--	0.27	0.29	--	--	Undetermined	--	0.29	#	0.34	[bk]
Barium	µg/g	2 / 2	2 / 2	100%	--	--	32	36	--	--	Undetermined	--	36	#	121	[bk]
Calcium	µg/g	2 / 2	2 / 2	100%	--	--	22,900	24,600	--	--	Undetermined	--	24,600	#	85,800	[bk]
Copper	µg/g	2 / 2	2 / 2	100%	--	--	28	35	--	--	Undetermined	--	35	#	36	[bk]
Iron	µg/g	2 / 2	2 / 2	100%	--	--	141	147	--	--	Undetermined	--	147	#	318	[bk]
Lead	µg/g	2 / 2	2 / 2	100%	--	--	0.19	0.28	--	--	Undetermined	--	0.28	#	0.26	[CEB]
Magnesium	µg/g	2 / 2	2 / 2	100%	--	--	482	587	--	--	Undetermined	--	587	#	1,401	[bk]
Manganese	µg/g	2 / 2	2 / 2	100%	--	--	183	205	--	--	Undetermined	--	205	#	933	[bk]
Nickel	µg/g	1 / 2	1 / 2	50%	0.83	0.83	2.5	2.5	--	--	Undetermined	--	2.5	#	--	[CEB]
Potassium	µg/g	2 / 2	2 / 2	100%	--	--	1,690	2,400	--	--	Undetermined	--	2,400	#	3,227	[bk]
Selenium	µg/g	2 / 2	2 / 2	100%	--	--	0.18	0.27	--	--	Undetermined	--	0.27	#	0.12	[CEB]
Silver	µg/g	2 / 2	2 / 2	100%	--	--	0.80	1.00	--	--	Undetermined	--	1.00	#	2.3	[bk]
Sodium	µg/g	2 / 2	2 / 2	100%	--	--	1,340	1,820	--	--	Undetermined	--	1,820	#	3,033	[bk]
Zinc	µg/g	2 / 2	2 / 2	100%	--	--	17	20	--	--	Undetermined	--	20	#	47	[bk]
Endrin Aldehyde	µg/g	1 / 2	1 / 2	50%	0.0033	0.0033	0.0036	0.0036	--	--	Undetermined	--	0.0036	#	--	[CEB]
Phenol	µg/g	1 / 2	1 / 2	50%	0.66	0.66	0.17	0.17	--	--	Undetermined	--	0.17	#	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

are represented by samples BC-26-004 and BC-26-005 (see Figure 4-57). Crayfish collected from the east Beaver Pond (Study Area 27) also showed relatively higher concentrations of many of the same metals as those in crayfish from Study Area 26 (Tables 4-102 and 4-103). Four metals exceeded background in crayfish from Talladega Creek.

Explosives—Explosives were not detected in any of the crayfish tissue samples analyzed.

SVOCs—Because of the large amount of tissue required and small number of samples collected, several of the samples were not analyzed for SVOCs. SVOC analysis was conducted on six samples from the Crossover Ditch (Study Area 26), two from the east Beaver Pond (Study Area 27), and two from the Talladega Creek tributary. Four SVOCs were detected: 4-methyl phenol, benzoic acid, phenol, and B2EHP, as shown in the adjacent box. 4-Methyl phenol (0.14 to 0.34 µg/g) was detected in tissue from two crayfish collected from the Crossover Ditch (Study Area 26), and one crayfish collected from the east Beaver Pond (Study Area 27). Benzoic acid (0.15 to 0.34 µg/g) was detected in three crayfish collected from the Crossover Ditch. B2EHP (0.136 µg/g) was detected in one crayfish from the Crossover Ditch. Phenol (0.16 to 0.36 µg/g) was detected in tissue from three crayfish collected from the Crossover Ditch, and one crayfish collected from the east Beaver Pond, and one crayfish from the Talladega Creek tributary. The maximum concentration of SVOCs were detected in the tissues of crayfish collected from the Crossover Ditch. All SVOC detections were below the CRLs.

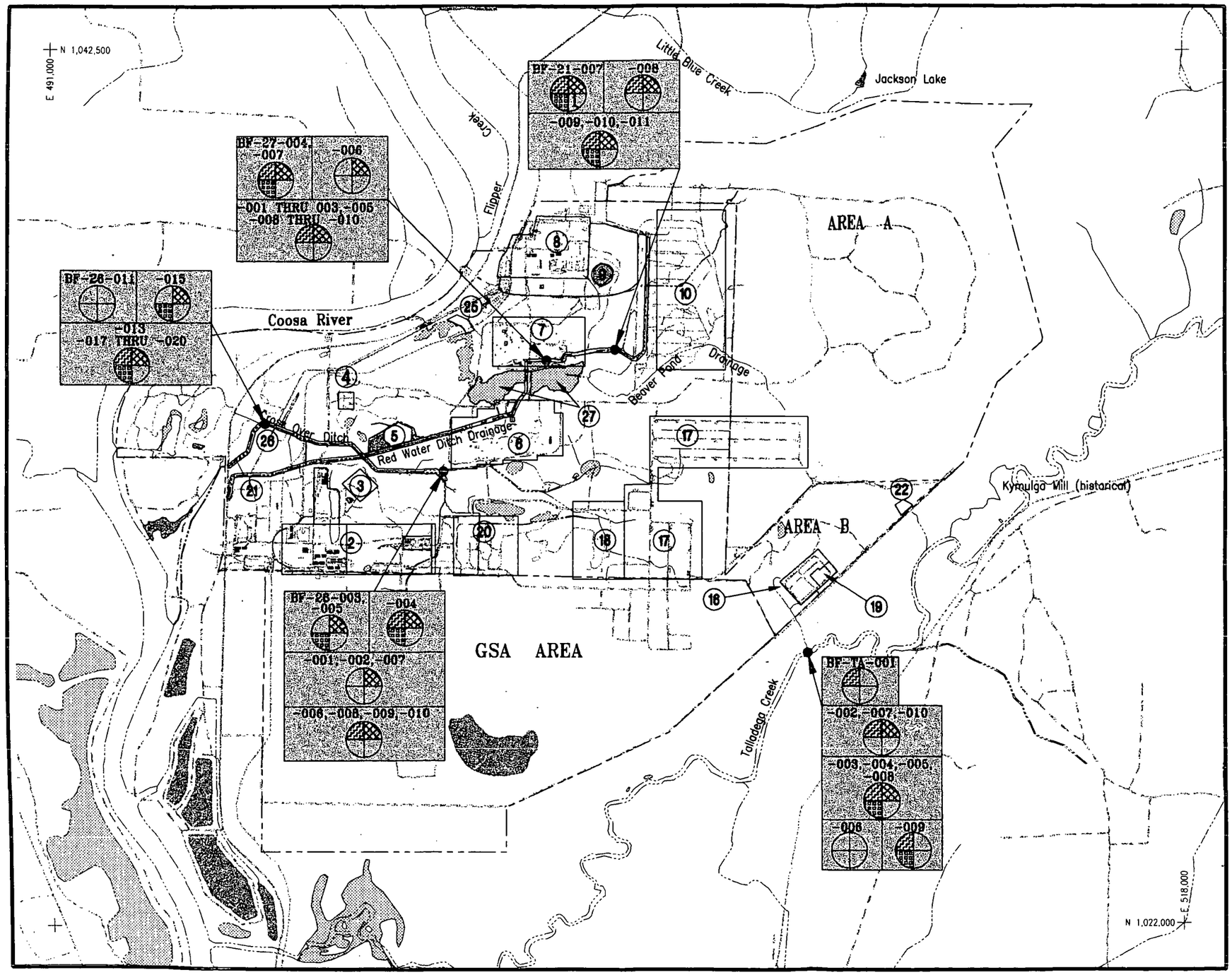
Maximum Concentrations (µg/g)			
Analyte	Study Area 26	Study Area 27	Talladega Creek Tributary
4-Methyl Phenol	0.34	0.142	
Benzoic Acid	0.34		
Phenol	0.36	0.16	0.168
B2EHP	0.136		

Pesticides/PCBs—One pesticide, endrin aldehyde (0.0036 µg/g), was detected in one crayfish from the Talladega Creek tributary.

Summary—Concentrations of fourteen metals exceeded background levels in the crayfish samples. In general, the highest concentrations of metals and SVOCs were detected in crayfish from Study Area 26, the Crossover Ditch. Explosives were not detected in any of the crayfish analyzed. One pesticide, endrin aldehyde, was detected in one crayfish from Talladega Creek.

4.8.3 Fish

Fish samples were analyzed from four study areas (Study Areas 21, 26, 27, and the Talladega Creek tributary) during the Supplemental RI investigation. Forty-two fish, including fish fillets, were collected from four study areas. All samples were analyzed for metals, explosives, SVOCs, and pesticides/PCBs. In addition, two samples from Study Area 21 and four samples from Study Area 27 were analyzed for hexavalent chromium. **Figure 4-58** shows the sample locations



LEGEND:

- BUILDINGS
- PRIMARY ROADS
- SECONDARY ROADS
- AREA BOUNDARIES
- (27) STUDY AREAS
- RAIL ROAD
- CREEK, TRIBUTARIES AND RIVER
- WETLANDS
- PONDS, IMPOUNDMENTS
- GRID BASED ON ALABAMA STATE PLANE EAST
- BIOTA TISSUE CONFIRMATION SAMPLE
- FISH COLLECTION LOCATION

ANALYTICAL GROUPS
SVOCs METALS
PESTICIDES/PCBs EXPLOSIVES

NOTE:

1. CONTAMINANT GROUP NOT ANALYZED AT THIS LOCATION

STATE PLANE GRID

0 1250 2500 5000

SCALE: 1" = 2500'

U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

CEBs in Fish Tissue at ALAAP

Figure No.	Project No.	File Name	Date
4-58	01-0827-03-8178-045	99015\DWGS\E42PIE17	03-31-99

and identifies general contaminant group CEBs present in the fish tissue. **Tables 4-105** through **4-108** present fish tissue the summary statistics for the study areas. Data summary tables for individual samples are presented in Appendix K.

Metals—Eighteen metals were identified at concentrations that exceeded background in the fish samples, and are listed in the adjacent box.

Maximum Concentrations (µg/g)*				
Analyte	**Study Area 21**	**Study Area 26**	**Study Area 27**	**Talladega Creek Tributary**
Aluminum	397		349	75
Arsenic	4.35	4.4		0.71
Barium	9.5	6.2	18	8.9
Beryllium	**0.07**			
Calcium		191,000	277,000	179,000
Chromium			**13.5**	**0.69**
Cobalt	**0.95**		**1.3**	
Copper				3.2
Iron	**225**	110	172	149
Lead	**0.38**	0.3	0.43	**0.67**
Magnesium	815			
Manganese	61.1	101	**97**	118
Mercury		0.89		
Nickel			**6.1**	
Selenium	0.68	**1.2**		0.62
Silver	**0.32**			
Sodium	7580	9,870		
Vanadium				0.55

* Metals also determined to exceed background based on ANOVA evaluation are shown in bold.

At Study Area 21, beryllium (0.07 µg/g) and cobalt (0.95 µg/g) each were detected in only one sample. Iron (20.9 to 225 µg/g) was detected in all five fish tissue samples, while lead (0.14 to 0.38 µg/g) and silver (0.28 to 0.32 µg/g) were detected in three and two samples, respectively.

At Study Area 26, concentrations of selenium, which was detected in all samples, ranged from 0.19 to 1.2 µg/g.

At Study Area 27, chromium was detected in two fish tissue samples, while cobalt and nickel each were detected in only one sample. Manganese was detected in all 10 fish samples. Concentration ranges for these metals were as follows; chromium (0.49 to 13.5 µg/g), cobalt (1.3 µg/g), manganese (16.1 to 96.7 µg/g), and nickel (6.1 µg/g).

Chromium (0.69 µg/g) was detected in one sample from the Talladega Creek tributary. Concentrations of lead in the Talladega Creek tributary fish samples ranged from 0.14 to 0.67 µg/g.

Explosives—Explosives were not detected in any of the fish tissue samples.

SVOCs—Seven SVOCs were detected in fish samples, as shown in the adjacent box. Benzoic acid (0.227 to 1.02 µg/g) and benzyl alcohol (0.075 to 0.141 µg/g) were

Maximum Concentrations (µg/g)				
Analyte	**Study Area 21**	**Study Area 26**	**Study Area 27**	**Talladega Creek Tributary**
2-Methylnaphthalene				0.21
4-Methyl Phenol		0.09	0.077	1.8
Benzoic Acid	1.02	0.87	1.3	
Benzyl Alcohol	0.141	0.17	0.576	
Naphthalene				0.13
Phenol		0.13		
B2EHP				0.14

Table 4-105. Summary Statistics and Exposure Point Concentrations for Fish at Study Area 21 - Red Water Ditch
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:06:40 PM
Run Date: 3/29/99
Exposure Unit: 21_PS2

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	5 / 5	5 / 5	100%	- -	- -	23	397	140	156	Normal	289	289		52	[CEB][ANOVA]
Antimony	µg/g	1 / 5	1 / 5	20%	0.13	0.57	0.23	0.23	0.15	0.10	Normal	0.25	0.23	#	1.5	[bk]
Arsenic	µg/g	3 / 5	3 / 5	60%	0.20	0.30	0.17	4.4	1.0	1.9	Lognormal	227	4.4	#	0.26	[CEB][ANOVA]
Barium	µg/g	5 / 5	5 / 5	100%	- -	- -	3.0	9.5	5.2	2.9	Normal	7.9	7.9		5.7	[CEB][ANOVA]
Beryllium	µg/g	1 / 5	1 / 5	20%	0.070	0.100	0.070	0.070	0.051	0.012	Normal	0.063	0.063		- -	[CEB]
Calcium	µg/g	5 / 5	5 / 5	100%	- -	- -	7,910	12,500	10,620	1,789	Normal	12,326	12,326		64,348	[bk]
Cobalt	µg/g	1 / 5	1 / 5	20%	0.60	0.87	0.95	0.95	0.49	0.27	Lognormal	0.95	0.95		- -	[CEB]
Copper	µg/g	2 / 5	2 / 5	40%	2.3	2.5	0.51	0.82	1.00	0.32	Normal	1.3	0.82	#	3.0	[bk]
Iron	µg/g	5 / 5	5 / 5	100%	- -	- -	31	225	129	84	Normal	209	209		51	[CEB]
Lead	µg/g	3 / 5	3 / 5	60%	0.24	0.34	0.14	0.38	0.20	0.10	Lognormal	0.37	0.37		0.17	[CEB]
Magnesium	µg/g	5 / 5	5 / 5	100%	- -	- -	329	815	477	209	Normal	677	677		809	[CEB][ANOVA]
Manganese	µg/g	5 / 5	5 / 5	100%	- -	- -	20	61	38	19	Normal	56	56		36	[CEB][ANOVA]
Mercury	µg/g	5 / 5	5 / 5	100%	- -	- -	0.100	0.22	0.15	0.048	Normal	0.20	0.20		0.34	[bk]
Potassium	µg/g	5 / 5	5 / 5	100%	- -	- -	2,300	2,760	2,504	184	Normal	2,679	2,679		5,332	[bk]
Selenium	µg/g	5 / 5	5 / 5	100%	- -	- -	0.21	0.68	0.45	0.21	Normal	0.65	0.65		0.62	[CEB][ANOVA]
Silver	µg/g	2 / 5	2 / 5	40%	0.29	0.30	0.28	0.32	0.21	0.085	Normal	0.29	0.29		- -	[CEB]
Sodium	µg/g	5 / 5	5 / 5	100%	- -	- -	708	7,580	2,259	2,977	Lognormal	21,066	7,580	#	5,004	[CEB][ANOVA]
Vanadium	µg/g	2 / 5	2 / 5	40%	0.38	0.40	0.30	0.41	0.26	0.096	Normal	0.35	0.35		0.43	[bk]
Zinc	µg/g	5 / 5	5 / 5	100%	- -	- -	20	54	36	14	Normal	50	50		56	[bk]
2,2-bis(p-chlorophenyl)-1,1-dichl	µg/g	2 / 5	2 / 5	40%	0.0033	0.0033	0.0055	0.0083	0.0038	0.0030	Normal	0.0066	0.0066		- -	[CEB]
Aroclor 1254	µg/g	3 / 5	3 / 5	60%	0.033	0.033	0.054	0.14	0.069	0.058	Normal	0.12	0.12		- -	[CEB]
Benzoic Acid	µg/g	5 / 5	5 / 5	100%	- -	- -	0.23	1.0	0.67	0.30	Normal	0.95	0.95		- -	[CEB]
Benzyl Alcohol	µg/g	2 / 5	2 / 5	40%	0.66	1.3	0.075	0.14	0.37	0.28	Normal	0.64	0.14	#	- -	[CEB]
Heptachlor	µg/g	1 / 5	1 / 5	20%	0.0017	0.0017	0.0020	0.0020	0.0011	0.00051	Lognormal	0.0018	0.0018		- -	[CEB]
beta-BHC	µg/g	1 / 5	1 / 5	20%	0.0017	0.0017	0.0023	0.0023	0.0011	0.00065	Lognormal	0.0021	0.0021		- -	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.

[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).

[c] CRL - contract reporting limit.

[d] *Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).*

[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.

[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.

[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.

- - Not applicable (note: background comparison not conducted for organic compounds)

Table 4-106. Summary Statistics and Exposure Point Concentrations for Fish at Study Area 26 - Crossover Ditch
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:20:14 PM
Run Date: 3/29/99
Exposure Unit: 26__PS2

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	12 / 17	12 / 17	71%	5.2	19	9.7	49	18	13	Normal	23	23		52	[bk]
Antimony	µg/g	7 / 17	7 / 17	41%	0.19	0.48	0.20	1.2	0.42	0.35	Lognormal	0.67	0.67		1.5	[bk]
Arsenic	µg/g	3 / 17	3 / 17	18%	0.100	0.35	0.15	4.4	0.35	1.0	Lognormal	0.42	0.42		0.26	[CEB][ANOVA]
Barium	µg/g	10 / 17	10 / 17	59%	1.1	1.2	1.2	6.2	1.9	1.6	Lognormal	3.3	3.3		5.7	[CEB][ANOVA]
Calcium	µg/g	17 / 17	17 / 17	100%	--	--	2,520	191,000	18,751	44,553	Lognormal	25,048	25,048		64,348	[CEB][ANOVA]
Copper	µg/g	1 / 17	1 / 17	6%	0.85	2.3	1.4	1.4	0.73	0.27	Normal	0.84	0.84		3.0	[bk]
Iron	µg/g	15 / 17	15 / 17	88%	6.0	6.2	6.7	110	32	26	Lognormal	73	73		51	[CEB][ANOVA]
Lead	µg/g	11 / 17	11 / 17	65%	0.100	0.100	0.100	0.30	0.12	0.075	Normal	0.16	0.16		0.17	[CEB][ANOVA]
Magnesium	µg/g	17 / 17	17 / 17	100%	--	--	247	510	341	59	Lognormal	366	366		809	[bk]
Manganese	µg/g	17 / 17	17 / 17	100%	--	--	0.62	101	22	26	Lognormal	117	101	#	36	[CEB][ANOVA]
Mercury	µg/g	17 / 17	17 / 17	100%	--	--	0.050	0.89	0.27	0.24	Lognormal	0.50	0.50		0.34	[CEB][ANOVA]
Potassium	µg/g	17 / 17	17 / 17	100%	--	--	1,690	3,900	2,697	627	Normal	2,962	2,962		5,332	[bk]
Selenium	µg/g	17 / 17	17 / 17	100%	--	--	0.19	1.2	0.61	0.32	Normal	0.75	0.75		0.62	[CEB]
Sodium	µg/g	17 / 17	17 / 17	100%	--	--	600	9,870	2,068	2,192	Lognormal	2,927	2,927		5,004	[CEB][ANOVA]
Vanadium	µg/g	1 / 17	1 / 17	6%	0.38	0.40	0.43	0.43	0.21	0.057	Lognormal	0.23	0.23		0.43	[bk]
Zinc	µg/g	17 / 17	17 / 17	100%	--	--	13	56	29	11	Normal	34	34		56	[bk]
2,2-bis(p-chlorophenyl)-1,1-dichl	µg/g	8 / 17	8 / 17	47%	0.0033	0.0033	0.0025	0.028	0.0049	0.0066	Lognormal	0.0076	0.0076		--	[CEB]
2,2-bis (para-chlorophenyl)-1,1,1-	µg/g	1 / 17	1 / 17	6%	0.0033	0.0033	0.0045	0.0045	0.0018	0.00069	Lognormal	0.0020	0.0020		--	[CEB]
4-Methyl Phenol	µg/g	2 / 17	2 / 17	12%	0.33	0.33	0.070	0.090	0.15	0.029	Lognormal	0.17	0.090	#	--	[CEB]
Benzoic Acid	µg/g	10 / 17	10 / 17	59%	1.6	1.6	0.10	0.87	0.59	0.23	Lognormal	0.82	0.82		--	[CEB]
Benzyl Alcohol	µg/g	3 / 17	3 / 17	18%	0.66	0.66	0.12	0.17	0.30	0.076	Lognormal	0.36	0.17	#	--	[CEB]
Endrin Aldehyde	µg/g	3 / 17	3 / 17	18%	0.0033	0.0033	0.0051	0.0077	0.0025	0.0020	Lognormal	0.0032	0.0032		--	[CEB]
Phenol	µg/g	1 / 17	1 / 17	6%	0.33	0.33	0.13	0.13	0.16	0.0078	Lognormal	0.18	0.13	#	--	[CEB]
beta-BHC	µg/g	1 / 17	1 / 17	6%	0.0017	0.0017	0.0026	0.0026	0.00095	0.00042	Lognormal	0.0011	0.0011		--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.

[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).

[c] CRL - contract reporting limit.

[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).

[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.

[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.

[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.

-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-107. Summary Statistics and Exposure Point Concentrations for Fish at Study Area 27 - Beaver Pond Drainage System
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:30:00 PM
Run Date: 3/29/99
Exposure Unit: 27__PS2

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]	2 x BK Mean[g]	Background Comparison[g]
Aluminum	µg/g	9 / 10	9 / 10	90%	14	14	10	349	62	102	Lognormal	178	178	52	[CEB][ANOVA]
Arsenic	µg/g	2 / 10	2 / 10	20%	0.100	0.100	0.12	0.25	0.077	0.065	Lognormal	0.11	0.11	0.26	[bk]
Barium	µg/g	10 / 10	10 / 10	100%	--	--	1.9	18	5.5	4.5	Lognormal	9.0	9.0	5.7	[CEB][ANOVA]
Calcium	µg/g	10 / 10	10 / 10	100%	--	--	5,830	277,000	78,323	104,547	Lognormal	594,399	277,000 #	64,348	[CEB][ANOVA]
Chromium	µg/g	2 / 10	2 / 10	20%	0.45	0.50	0.49	14	1.6	4.2	Lognormal	4.1	4.1	--	[CEB]
Cobalt	µg/g	1 / 10	1 / 10	10%	0.86	1.7	1.3	1.3	0.56	0.29	Lognormal	0.73	0.73	--	[CEB]
Iron	µg/g	10 / 10	10 / 10	100%	--	--	9.8	172	56	47	Lognormal	138	138	51	[CEB][ANOVA]
Lead	µg/g	4 / 10	4 / 10	40%	0.100	0.100	0.100	0.43	0.11	0.12	Lognormal	0.20	0.20	0.17	[CEB][ANOVA]
Magnesium	µg/g	10 / 10	10 / 10	100%	--	--	249	595	438	101	Normal	496	496	809	[bk]
Manganese	µg/g	10 / 10	10 / 10	100%	--	--	16	97	45	28	Normal	61	61	36	[CEB]
Mercury	µg/g	10 / 10	10 / 10	100%	--	--	0.060	0.24	0.13	0.063	Normal	0.17	0.17	0.34	[bk]
Nickel	µg/g	1 / 10	1 / 10	10%	0.81	0.89	6.1	6.1	1.0	1.8	Lognormal	1.7	1.7	--	[CEB]
Potassium	µg/g	10 / 10	10 / 10	100%	--	--	1,760	3,090	2,356	378	Normal	2,575	2,575	5,332	[bk]
Selenium	µg/g	10 / 10	10 / 10	100%	--	--	0.16	0.45	0.28	0.082	Normal	0.32	0.32	0.62	[bk]
Sodium	µg/g	10 / 10	10 / 10	100%	--	--	557	4,460	1,947	1,232	Normal	2,660	2,660	5,004	[bk]
Zinc	µg/g	10 / 10	10 / 10	100%	--	--	23	54	38	11	Normal	45	45	56	[bk]
2,2-bis(p-chlorophenyl)-1,1-dichl	µg/g	1 / 10	1 / 10	10%	0.0033	0.0033	0.0040	0.0040	0.0019	0.00074	Lognormal	0.0023	0.0023	--	[CEB]
4-Methyl Phenol	µg/g	1 / 10	1 / 10	10%	0.33	0.33	0.077	0.077	0.16	0.028	Lognormal	0.18	0.077 #	--	[CEB]
Benzoic Acid	µg/g	5 / 10	5 / 10	50%	1.6	1.6	0.15	1.3	0.68	0.33	Normal	0.87	0.87	--	[CEB]
Benzyl Alcohol	µg/g	7 / 10	7 / 10	70%	0.66	0.66	0.071	0.58	0.32	0.15	Normal	0.41	0.41	--	[CEB]
Heptachlor	µg/g	1 / 10	1 / 10	10%	0.0017	0.0017	0.0027	0.0027	0.0010	0.00059	Lognormal	0.0013	0.0013	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-108. Summary Statistics and Exposure Point Concentrations for Fish at Study Area TA - Talladega Creek
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 7:27:35 PM
Run Date: 3/29/99
Exposure Unit: TA_PS2

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	10 / 10	10 / 10	100%	- -	- -	7.3	75	29	19	Normal	40	40		52	[CEB][ANOVA]
Antimony	µg/g	5 / 10	5 / 10	50%	0.19	0.20	0.20	0.74	0.23	0.20	Lognormal	0.41	0.41		1.5	[bk]
Arsenic	µg/g	4 / 10	4 / 10	40%	0.100	0.100	0.100	0.71	0.16	0.21	Lognormal	0.39	0.39		0.26	[CEB][ANOVA]
Barium	µg/g	6 / 10	6 / 10	60%	1.2	1.2	1.4	8.9	1.9	2.5	Lognormal	3.8	3.8		5.7	[CEB][ANOVA]
Calcium	µg/g	10 / 10	10 / 10	100%	- -	- -	2,480	179,000	28,105	53,434	Lognormal	81,575	81,575		64,348	[CEB][ANOVA]
Chromium	µg/g	1 / 10	1 / 10	10%	0.48	0.50	0.69	0.69	0.29	0.14	Lognormal	0.36	0.36		- -	[CEB]
Copper	µg/g	10 / 10	10 / 10	100%	- -	- -	1.00	3.2	1.8	0.84	Normal	2.3	2.3		3.0	[CEB][ANOVA]
Iron	µg/g	8 / 10	8 / 10	80%	6.1	6.3	12	149	44	48	Lognormal	301	149	#	51	[CEB][ANOVA]
Lead	µg/g	7 / 10	7 / 10	70%	0.100	0.49	0.14	0.67	0.21	0.18	Lognormal	0.43	0.43		0.17	[CEB]
Magnesium	µg/g	10 / 10	10 / 10	100%	- -	- -	301	502	381	65	Normal	418	418		809	[bk]
Manganese	µg/g	10 / 10	10 / 10	100%	- -	- -	1.9	118	23	35	Lognormal	96	96		36	[CEB][ANOVA]
Mercury	µg/g	10 / 10	10 / 10	100%	- -	- -	0.050	0.14	0.086	0.029	Normal	0.10	0.10		0.34	[bk]
Potassium	µg/g	10 / 10	10 / 10	100%	- -	- -	1,930	3,660	2,537	510	Normal	2,832	2,832		5,332	[bk]
Selenium	µg/g	9 / 10	9 / 10	90%	0.20	0.20	0.16	0.62	0.27	0.16	Lognormal	0.41	0.41		0.62	[CEB][ANOVA]
Sodium	µg/g	10 / 10	10 / 10	100%	- -	- -	479	2,280	1,059	526	Normal	1,364	1,364		5,004	[bk]
Vanadium	µg/g	1 / 10	1 / 10	10%	0.38	0.40	0.55	0.55	0.23	0.11	Lognormal	0.28	0.28		0.43	[CEB][ANOVA]
Zinc	µg/g	10 / 10	10 / 10	100%	- -	- -	12	32	23	6.4	Normal	27	27		56	[bk]
2-Methylnaphthalene	µg/g	5 / 10	5 / 10	50%	0.33	0.33	0.091	0.21	0.15	0.031	Lognormal	0.18	0.18		- -	[CEB]
2,2-bis(p-chlorophenyl)-1,1-dichl	µg/g	5 / 10	5 / 10	50%	0.0033	0.0033	0.0035	0.012	0.0044	0.0038	Lognormal	0.0092	0.0092		- -	[CEB]
4-Methyl Phenol	µg/g	7 / 10	7 / 10	70%	0.33	0.33	0.17	1.8	0.44	0.49	Lognormal	0.85	0.85		- -	[CEB]
Aldrin	µg/g	1 / 10	1 / 10	10%	0.0017	0.0017	0.0053	0.0053	0.0013	0.0014	Lognormal	0.0019	0.0019		- -	[CEB]
Endrin Aldehyde	µg/g	3 / 10	3 / 10	30%	0.0033	0.0033	0.0035	0.0062	0.0027	0.0018	Lognormal	0.0040	0.0040		- -	[CEB]
Heptachlor Epoxide	µg/g	3 / 10	3 / 10	30%	0.0017	0.0017	0.0019	0.0031	0.0014	0.00091	Lognormal	0.0021	0.0021		- -	[CEB]
Lindane	µg/g	1 / 10	1 / 10	10%	0.0017	0.0017	0.0038	0.0038	0.0011	0.00093	Lognormal	0.0016	0.0016		- -	[CEB]
Naphthalene	µg/g	1 / 10	1 / 10	10%	0.33	0.33	0.13	0.13	0.16	0.012	Lognormal	0.18	0.13	#	- -	[CEB]
beta-BHC	µg/g	1 / 10	1 / 10	10%	0.0017	0.0017	0.0017	0.0017	0.00094	0.00027	Lognormal	0.0011	0.0011		- -	[CEB]
bis(2-Ethylhexyl)phthalate	µg/g	2 / 10	2 / 10	20%	0.33	0.33	0.10	0.14	0.16	0.020	Lognormal	0.17	0.14	#	- -	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
- - Not applicable (note: background comparison not conducted for organic compounds)

detected in tissue samples of fish collected from Study Area 21. Benzoic acid was detected in all five fish tissue samples from Study Area 21, while benzyl alcohol was detected in two samples.

4-Methyl phenol was detected in only one Study Area 21 fish tissue sample, while benzoic acid and benzyl alcohol were detected in five and seven samples, respectively.

4-Methyl phenol (0.07 to 0.09 µg/g), benzoic acid (0.10 to 0.87 µg/g), benzyl alcohol (0.12 to 0.17 µg/g), and phenol (0.13 µg/g) were detected in fish tissue samples from Study Area 26. Benzoic acid was detected in 10 of the 17 fish tissue samples at this study area, while the other SVOCs were detected in three or fewer samples.

4-Methyl phenol (0.077 µg/g), benzoic acid (0.15 to 1.3 µg/g), and benzyl alcohol (0.071 to 0.576 µg/g) were detected in Study Area 27 fish tissue samples.

2-Methylnaphthalene (0.091 to 0.21 µg/g), 4-methyl phenol (0.17 to 1.8 µg/g), naphthalene (0.13 µg/g), and B2EHP (0.10 to 0.14 µg/g) were detected in the tissue samples from fish collected from the Talladega Creek tributary.

Of the SVOCs detected in fish tissue, only 4-methyl phenol (1.8 µg/g) at the Talladega Creek tributary exceeded the CRL. Of the 10 tissue samples collected from the Talladega Creek tributary, five samples exceeded the CRL for 4-methyl phenol.

Pesticides/PCBs—Eight pesticides and one PCB were detected in the fish tissue samples, as shown in the adjacent box. 4,4′-DDE (0.0055 to 0.0083 µg/g), beta-BHC (0.0023 µg/g), heptachlor (0.002 µg/g), and Aroclor-1254 (0.054 to 0.14 µg/g), were detected in Study Area 21 fish tissue samples.

	Maximum Concentrations (µg/g)			
Analyte	Study Area 21	Study Area 26	Study Area 27	Talladega Creek Tributary
4,4′-DDE	0.0083	0.028	0.004	0.012
4,4′-DDT		0.0045		
Aldrin				0.0053
Aroclor-1254	0.14			
Beta-BHC	0.0023	0.0026		0.0017
Endrin Aldehyde		0.0077		0.0062
Heptachlor	0.002		0.0027	
Heptachlor Epoxide				0.0031
Lindane				0.0038

4,4′-DDE (0.0025 to 0.028 µg/g), 4,4′-DDT (0.0045 µg/g), beta-BHC (0.0026 µg/g), and endrin aldehyde (0.0051 to 0.0077 µg/g) were detected in Study Area 26 fish tissue samples.

4,4′-DDE (0.004 µg/g), and heptachlor (0.0027 µg/g) were each detected in one sample of Study Area 27 fish tissue.

Six pesticides were detected in the Talladega Creek tributary fish tissue samples. 4,4′-DDE (0.0035 to 0.012 µg/g), aldrin (0.0053 µg/g), beta-BHC (0.0017 µg/g), endrin aldehyde (0.0035 to

0.0062 µg/g), heptachlor epoxide (0.0019 to 0.0031 µg/g), and lindane (0.0038 µg/g) were detected in the tissue samples of fish collected from the Talladega Creek tributary.

Summary—Eighteen metals exceeded background concentrations in fish tissue samples, with at least nine metals exceeding background in fish samples from each study area. SVOCs were detected in samples from all study areas, but only 4-methyl phenol was detected above the CRL. Eight pesticides and one PCB (Aroclor-1254) were detected in the fish tissue samples.

4.8.4 Fish Fillets

Two fish fillets were collected from each of Study Areas 26, 27, and the Talladega Creek tributary. Fish fillet samples were analyzed for explosives, metals, SVOCs, and pesticides/PCBs. The summary statistics for fish fillets are presented in **Tables 4-109** through **4-111**. **Figure 4-59** summarizes general groups of analytes (metals, explosives, and SVOCs) detected in fish fillet tissue at each sample location. Appendix K provides data summary tables for fish fillet tissue.

Metals—Ten metals were identified at concentrations that exceeded background (CEBs), and are listed in the adjacent box. Eight of ten metals identified in the three study areas exceeded background at Study Area 27, three metals exceeded background at Study Area 26, and only two metals exceeded background at the Talladega Creek tributary.

Maximum Concentrations (µg/g)*			
Analyte	Study Area 26	Study Area 27	Talladega Creek Tributary
Barium		3.7	
Calcium		182,000	
Chromium		14	
Cobalt		1.3	
Iron		68	
Lead	0.14		0.15
Manganese		19	
Mercury	0.89		
Nickel		6.1	
Selenium	0.69	0.30	0.16

* ANOVA evaluation not conducted because there are fewer than four samples in the background data set.

Explosives—Explosives were not detected in any of the fish fillet samples.

SVOCs—Three SVOCs were detected in fish fillet samples from the Talladega Creek tributary, and one SVOC was detected at Study Area 27. SVOCs were not detected at Study Area 26, as shown in the adjacent box. Of the four SVOCs detected in the fish fillet samples, only 4-methyl phenol (1.76 µg/g) in one Talladega Creek tributary sample exceeded the CRL.

Maximum Concentrations (µg/g)		
Analyte	Study Area 27	Talladega Creek Tributary
2-Methylnaphthalene		0.0909
4-Methyl Phenol		1.76
Benzyl Alcohol	0.148	
B2EHP		0.138

Pesticides/PCBs—Pesticides and PCBs were not detected in any of the fish fillet samples.

Table 4-109. Summary Statistics and Exposure Point Concentrations for Fish Fillets at Study Area 26 - Crossover Ditch
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:22:45 PM
Run Date: 3/29/99
Exposure Unit: 26__PS4

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	1 / 2	1 / 2	50%	5.2	5.2	9.7	9.7	--	--	Undetermined	--	9.7	#	24	[bk]
Calcium	µg/g	2 / 2	2 / 2	100%	--	--	2,890	4,940	--	--	Undetermined	--	4,940	#	13,340	[bk]
Iron	µg/g	1 / 2	1 / 2	50%	6.2	6.2	6.7	6.7	--	--	Undetermined	--	6.7	#	24	[bk]
Lead	µg/g	1 / 2	1 / 2	50%	0.100	0.100	0.14	0.14	--	--	Undetermined	--	0.14	#	--	[CEB]
Magnesium	µg/g	2 / 2	2 / 2	100%	--	--	291	357	--	--	Undetermined	--	357	#	668	[bk]
Manganese	µg/g	2 / 2	2 / 2	100%	--	--	0.62	0.74	--	--	Undetermined	--	0.74	#	9.1	[bk]
Mercury	µg/g	2 / 2	2 / 2	100%	--	--	0.62	0.89	--	--	Undetermined	--	0.89	#	0.42	[CEB]
Potassium	µg/g	2 / 2	2 / 2	100%	--	--	3,870	3,900	--	--	Undetermined	--	3,900	#	6,280	[bk]
Selenium	µg/g	2 / 2	2 / 2	100%	--	--	0.31	0.69	--	--	Undetermined	--	0.69	#	--	[CEB]
Sodium	µg/g	2 / 2	2 / 2	100%	--	--	627	4,000	--	--	Undetermined	--	4,000	#	4,300	[bk]
Zinc	µg/g	2 / 2	2 / 2	100%	--	--	13	17	--	--	Undetermined	--	17	#	42	[bk]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.

[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).

[c] CRL - contract reporting limit.

[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).

[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.

[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.

[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.

-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-110. Summary Statistics and Exposure Point Concentrations for Fish Fillets at Study Area 27 - Beaver Pond Drainage System
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 6:32:27 PM
Run Date: 3/29/99
Exposure Unit: 27__PS4

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[g]	Background Comparison[g]
Aluminum	µg/g	1 / 2	1 / 2	50%	14	14	24	24	--	--	Undetermined	--	24	#	24	[bk]
Barium	µg/g	2 / 2	2 / 2	100%	--	--	1.9	3.7	--	--	Undetermined	--	3.7	#	1.9	[CEB]
Calcium	µg/g	2 / 2	2 / 2	100%	--	--	8,600	182,000	--	--	Undetermined	--	182,000	#	13,340	[CEB]
Chromium	µg/g	1 / 2	1 / 2	50%	0.48	0.48	14	14	--	--	Undetermined	--	14	#	--	[CEB]
Cobalt	µg/g	1 / 2	1 / 2	50%	0.88	0.88	1.3	1.3	--	--	Undetermined	--	1.3	#	--	[CEB]
Iron	µg/g	2 / 2	2 / 2	100%	--	--	9.8	68	--	--	Undetermined	--	68	#	24	[CEB]
Magnesium	µg/g	2 / 2	2 / 2	100%	--	--	335	481	--	--	Undetermined	--	481	#	668	[bk]
Manganese	µg/g	2 / 2	2 / 2	100%	--	--	16	19	--	--	Undetermined	--	19	#	9.1	[CEB]
Mercury	µg/g	2 / 2	2 / 2	100%	--	--	0.17	0.20	--	--	Undetermined	--	0.20	#	0.42	[bk]
Nickel	µg/g	1 / 2	1 / 2	50%	0.87	0.87	6.1	6.1	--	--	Undetermined	--	6.1	#	--	[CEB]
Potassium	µg/g	2 / 2	2 / 2	100%	--	--	2,840	3,090	--	--	Undetermined	--	3,090	#	6,280	[bk]
Selenium	µg/g	2 / 2	2 / 2	100%	--	--	0.24	0.30	--	--	Undetermined	--	0.30	#	--	[CEB]
Sodium	µg/g	2 / 2	2 / 2	100%	--	--	658	1,010	--	--	Undetermined	--	1,010	#	4,300	[bk]
Zinc	µg/g	2 / 2	2 / 2	100%	--	--	27	30	--	--	Undetermined	--	30	#	42	[bk]
Benzyl Alcohol	µg/g	2 / 2	2 / 2	100%	--	--	0.071	0.15	--	--	Undetermined	--	0.15	#	--	[CEB]

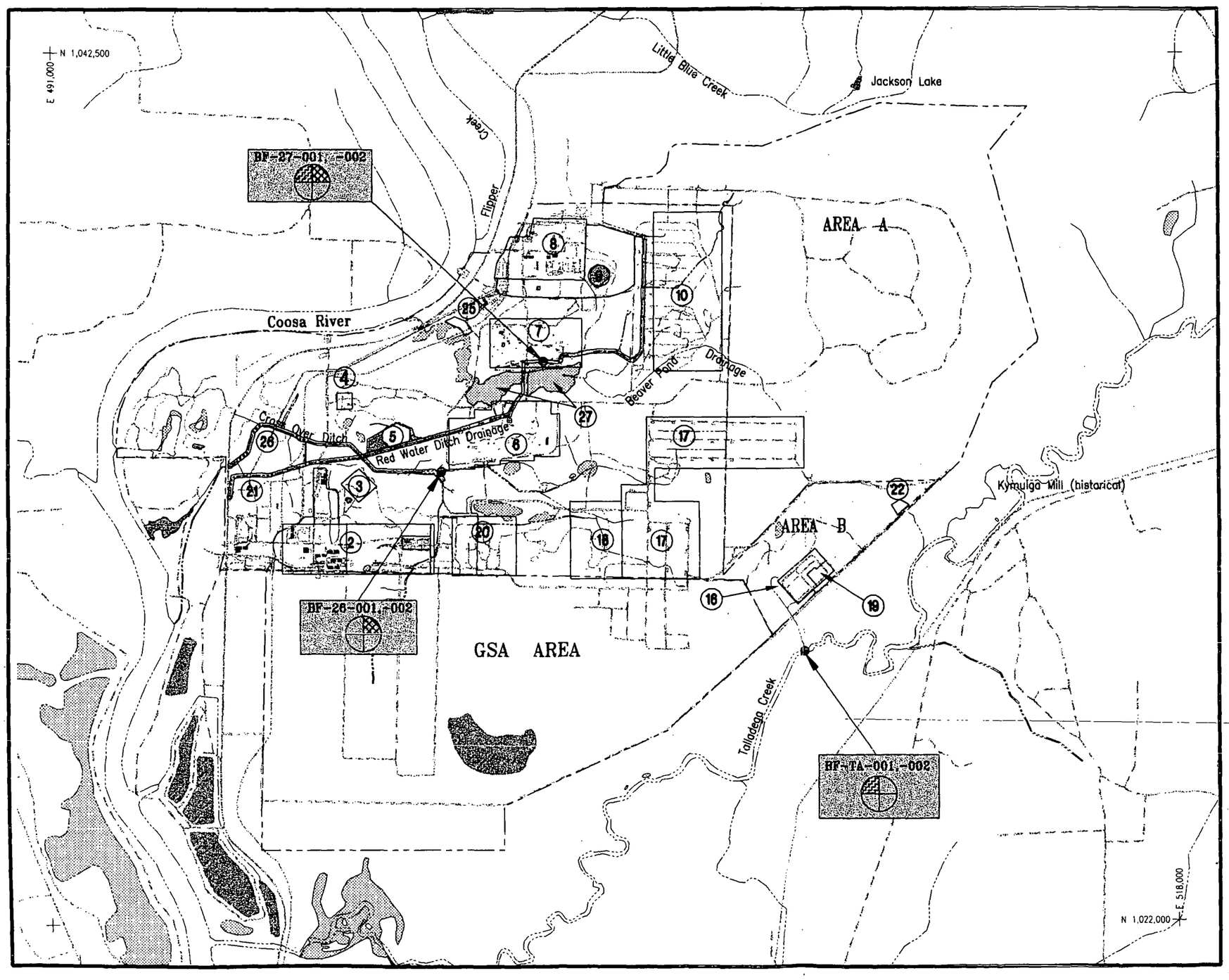
[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-111. Summary Statistics and Exposure Point Concentrations for Fish Fillets at Study Area TA - Talladega Creek
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 7:30:04 PM
Run Date: 3/29/99
Exposure Unit: TA_PS4

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Aluminum	µg/g	2 / 2	2 / 2	100%	--	--	7.3	13	--	--	Undetermined	--	13	#	24	[bk]
Antimony	µg/g	2 / 2	2 / 2	100%	--	--	0.26	0.74	--	--	Undetermined	--	0.74	#	1.3	[bk]
Arsenic	µg/g	1 / 2	1 / 2	50%	0.100	0.100	0.31	0.31	--	--	Undetermined	--	0.31	#	0.33	[bk]
Calcium	µg/g	2 / 2	2 / 2	100%	--	--	2,480	7,660	--	--	Undetermined	--	7,660	#	13,340	[bk]
Copper	µg/g	2 / 2	2 / 2	100%	--	--	1.1	2.4	--	--	Undetermined	--	2.4	#	6.8	[bk]
Lead	µg/g	2 / 2	2 / 2	100%	--	--	0.14	0.15	--	--	Undetermined	--	0.15	#	--	[CEB]
Magnesium	µg/g	2 / 2	2 / 2	100%	--	--	301	348	--	--	Undetermined	--	348	#	668	[bk]
Manganese	µg/g	2 / 2	2 / 2	100%	--	--	1.9	2.2	--	--	Undetermined	--	2.2	#	9.1	[bk]
Mercury	µg/g	2 / 2	2 / 2	100%	--	--	0.11	0.14	--	--	Undetermined	--	0.14	#	0.42	[bk]
Potassium	µg/g	2 / 2	2 / 2	100%	--	--	2,820	3,660	--	--	Undetermined	--	3,660	#	6,280	[bk]
Selenium	µg/g	1 / 2	1 / 2	50%	0.20	0.20	0.16	0.16	--	--	Undetermined	--	0.16	#	--	[CEB]
Sodium	µg/g	2 / 2	2 / 2	100%	--	--	479	640	--	--	Undetermined	--	640	#	4,300	[bk]
Zinc	µg/g	2 / 2	2 / 2	100%	--	--	16	17	--	--	Undetermined	--	17	#	42	[bk]
2-Methylnaphthalene	µg/g	1 / 2	1 / 2	50%	0.33	0.33	0.091	0.091	--	--	Undetermined	--	0.091	#	--	[CEB]
4-Methyl Phenol	µg/g	1 / 2	1 / 2	50%	0.33	0.33	1.8	1.8	--	--	Undetermined	--	1.8	#	--	[CEB]
bis(2-Ethylhexyl)phthalate	µg/g	2 / 2	2 / 2	100%	--	--	0.10	0.14	--	--	Undetermined	--	0.14	#	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)



LEGEND:

- BUILDINGS
- PRIMARY ROADS
- SECONDARY ROADS
- TRAILS
- FENCE
- AREA BOUNDARIES
- (27) STUDY AREAS
- RAIL ROAD
- CREEK, TRIBUTARIES AND RIVER
- WETLANDS
- PONDS, IMPOUNDMENTS
- GRID BASED ON ALABAMA STATE PLANE EAST
- BIOTA TISSUE CONFIRMATION SAMPLE
- FISH COLLECTION LOCATION

ANALYTICAL GROUPS
SVOCs, METALS, PESTICIDES/PCBs, EXPLOSIVES

STATE PLANE GRID

0 1250 2500 5000
SCALE: 1" = 2500'

U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

CEBs in Fish Fillets at ALAAP

Figure No.	Project No.	File Name	Date
4-59	01-0827-03-8178-045	99015\DWGS\E42PIE54	03-31-99

samples.

4.8.5 Rabbits

Twelve rabbits were collected from Study Areas 8 (3 rabbits), 10 (3 rabbits), 16 (2 rabbits), and 17 (4 rabbits), and tissue samples were analyzed for explosives, metals, SVOCs, and pesticides/PCBs. Two of the rabbits (BR-17-003 and BR-17-004) from Study Area 17 were combined into a single sample (BR-17-004) to yield sufficient tissue for analysis. In addition, Study Area 8 rabbit samples and one Study Area 16 rabbit sample were analyzed for hexavalent chromium. **Tables 4-112** through **4-115** present the summary statistics for rabbit tissue samples. **Figure 4-60** summarizes general contaminant group CEBs (metals, explosives, and SVOCs) detected in rabbit tissue at each sample location. Appendix K provides data summary tables for rabbit tissue.

Metals—Eight metals were identified at concentrations that exceeded background, and are listed in the adjacent box. All CEB metals except arsenic were detected in rabbits captured at Study Area 16. Arsenic exceeded background concentrations in rabbit samples collected from the Study Areas 8, 10, and 17. Arsenic was detected in 5 of the 11 samples analyzed.

	Maximum Concentrations (µg/g)*			
Analyte	Study Area 8	Study Area 10	Study Area 16	Study Area 17
Arsenic	0.13	0.13		0.25
Calcium			7,730	
Chromium			0.61	
Copper	1	0.69	0.50	1.2
Manganese			0.81	
Nickel	3.1		3.7	
Selenium	0.16		0.15	
Silver			0.45	

* ANOVA evaluation was not conducted because there are fewer than four samples in the background data set.

Concentrations of copper in rabbit tissue from all study areas exceeded background. Copper was not detected in the background rabbit tissue samples. Copper was detected in 10 of the 11 rabbit samples analyzed from the four study areas, at concentrations ranging from 0.5 to 1.2 µg/g. Concentrations of copper were highest in tissue collected from Study Area 17, with a range from 1.1 to 1.2 µg/g.

Chromium was detected in only one rabbit sample collected from Study Area 16 at a concentration of 0.61 µg/g. Manganese was detected in a single rabbit sample from Study Area 16 at a concentration of 0.81 µg/g. Silver was detected in both rabbit samples collected in Study Area 16 at concentrations of 0.4 and 0.45 µg/g. Nickel was detected in one rabbit sample from Study Area 8 and two rabbit samples from Study Area 16.

Table 4-112. Summary Statistics and Exposure Point Concentrations for Rabbits at Study Area 8 - Acid/Organic Manufacturing Area
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:27:11 PM
Run Date: 3/29/99
Exposure Unit: 08__PS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[g]	Bac Con
Aluminum	µg/g	1 / 3	1 / 3	33%	2.8	2.9	3.0	3.0	--	--	Undetermined	--	3.0	#	14	
Antimony	µg/g	1 / 3	1 / 3	33%	0.19	0.20	0.23	0.23	--	--	Undetermined	--	0.23	#	1.3	
Arsenic	µg/g	2 / 3	2 / 3	67%	0.100	0.100	0.100	0.13	--	--	Undetermined	--	0.13	#	--	[
Calcium	µg/g	3 / 3	3 / 3	100%	--	--	60	100	--	--	Undetermined	--	100	#	6,092	
Copper	µg/g	3 / 3	3 / 3	100%	--	--	0.58	1.00	--	--	Undetermined	--	1.00	#	--	[
Iron	µg/g	3 / 3	3 / 3	100%	--	--	10	14	--	--	Undetermined	--	14	#	30	
Magnesium	µg/g	3 / 3	3 / 3	100%	--	--	245	281	--	--	Undetermined	--	281	#	620	
Nickel	µg/g	1 / 3	1 / 3	33%	0.88	0.89	3.1	3.1	--	--	Undetermined	--	3.1	#	2 0	[
Potassium	µg/g	3 / 3	3 / 3	100%	--	--	3,700	4,110	--	--	Undetermined	--	4,110	#	7,600	
Selenium	µg/g	1 / 3	1 / 3	33%	0.100	0.100	0.16	0.16	--	--	Undetermined	--	0.16	#	--	[
Sodium	µg/g	3 / 3	3 / 3	100%	--	--	458	617	--	--	Undetermined	--	617	#	994	
Zinc	µg/g	1 / 3	1 / 3	33%	14	15	12	12	--	--	Undetermined	--	12	#	28	
4-Methyl Phenol	µg/g	1 / 3	1 / 3	33%	0.33	0.33	0.10	0.10	--	--	Undetermined	--	0.10	#	--	[
Benzoic Acid	µg/g	1 / 3	1 / 3	33%	1.6	1.6	0.086	0.086	--	--	Undetermined	--	0.086	#	--	[
bis(2-Ethylhexyl)phthalate	µg/g	2 / 3	2 / 3	67%	0.33	0.33	0.10	0.15	--	--	Undetermined	--	0.15	#	--	[

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.

[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).

[c] CRL - contract reporting limit.

[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).

[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.

[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EP

[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.

-- Not applicable (note: background comparison not conducted for organic compounds)

Summary—Ten metals were identified at concentrations that exceeded background in fish fillets. One SVOC, 4-methyl phenol, was detected above the CRL in a fish fillet from the Talladega Creek tributary. PCBs, pesticides, and explosives were not detected in any fish fillet samples.

4.8.5 Rabbits

Twelve rabbits were collected from Study Areas 8 (3 rabbits), 10 (3 rabbits), 16 (2 rabbits), and 17 (4 rabbits), and tissue samples were analyzed for explosives, metals, SVOCs, and pesticides/PCBs. Two of the rabbits (BR-17-003 and BR-17-004) from Study Area 17 were combined into a single sample (BR-17-004) to yield sufficient tissue for analysis. In addition, Study Area 8 rabbit samples and one Study Area 16 rabbit sample were analyzed for hexavalent chromium. **Tables 4-112** through **4-115** present the summary statistics for rabbit tissue samples. **Figure 4-60** summarizes general contaminant group CEBs (metals, explosives, and SVOCs) detected in rabbit tissue at each sample location. Appendix K provides data summary tables for rabbit tissue.

Metals—Eight metals were identified at concentrations that exceeded background, and are listed in the adjacent box. All CEB metals except arsenic were detected in rabbits captured at Study Area 16. Arsenic exceeded background concentrations in rabbit samples collected from the Study Areas 8, 10, and 17. Arsenic was detected in 5 of the 11 samples analyzed.

	Maximum Concentrations (µg/g)*			
Analyte	**Study Area 8**	**Study Area 10**	**Study Area 16**	**Study Area 17**
Arsenic	0.13	0.13		0.25
Calcium			7,730	
Chromium			0.61	
Copper	1	0.69	0.50	1.2
Manganese			0.81	
Nickel	3.1		3.7	
Selenium	0.16		0.15	
Silver			0.45	

* ANOVA evaluation was not conducted because there are fewer than four samples in the background data set.

Concentrations of copper in rabbit tissue from all study areas exceeded background. Copper was not detected in the background rabbit tissue samples. Copper was detected in 10 of the 11 rabbit samples analyzed from the four study areas, at concentrations ranging from 0.5 to 1.2 µg/g. Concentrations of copper were highest in tissue collected from Study Area 17, with a range from 1.1 to 1.2 µg/g.

Chromium was detected in only one rabbit sample collected from Study Area 16 at a concentration of 0.61 µg/g. Manganese was detected in a single rabbit sample from Study Area 16 at a concentration of 0.81 µg/g. Silver was detected in both rabbit samples collected in Study Area 16 at concentrations of 0.4 and 0.45 µg/g. Nickel was detected in one rabbit sample from Study Area 8 and two rabbit samples from Study Area 16.

Table 4-112. Summary Statistics and Exposure Point Concentrations for Rabbits at Study Area 8 - Acid/Organic Manufacturing Area
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:27:11 PM
Run Date: 3/29/99.
Exposure Unit: 08__PS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[g]	Background Comparison[g]
Aluminum	µg/g	1 / 3	1 / 3	33%	2.8	2.9	3.0	3.0	--	--	Undetermined	--	3.0	#	14	[bk]
Antimony	µg/g	1 / 3	1 / 3	33%	0.19	0.20	0.23	0.23	--	--	Undetermined	--	0.23	#	1.3	[bk]
Arsenic	µg/g	2 / 3	2 / 3	67%	0.100	0.100	0.100	0.13	--	--	Undetermined	--	0.13	#	--	[CEB]
Calcium	µg/g	3 / 3	3 / 3	100%	--	--	60	100	--	--	Undetermined	--	100	#	6,092	[bk]
Copper	µg/g	3 / 3	3 / 3	100%	--	--	0.58	1.00	--	--	Undetermined	--	1.00	#	--	[CEB]
Iron	µg/g	3 / 3	3 / 3	100%	--	--	10	14	--	--	Undetermined	--	14	#	30	[bk]
Magnesium	µg/g	3 / 3	3 / 3	100%	--	--	245	281	--	--	Undetermined	--	281	#	620	[bk]
Nickel	µg/g	1 / 3	1 / 3	33%	0.88	0.89	3.1	3.1	--	--	Undetermined	--	3.1	#	2.0	[CEB]
Potassium	µg/g	3 / 3	3 / 3	100%	--	--	3,700	4,110	--	--	Undetermined	--	4,110	#	7,600	[bk]
Selenium	µg/g	1 / 3	1 / 3	33%	0.100	0.100	0.16	0.16	--	--	Undetermined	--	0.16	#	--	[CEB]
Sodium	µg/g	3 / 3	3 / 3	100%	--	--	458	617	--	--	Undetermined	--	617	#	994	[bk]
Zinc	µg/g	1 / 3	1 / 3	33%	14	15	12	12	--	--	Undetermined	--	12	#	28	[bk]
4-Methyl Phenol	µg/g	1 / 3	1 / 3	33%	0.33	0.33	0.10	0.10	--	--	Undetermined	--	0.10	#	--	[CEB]
Benzoic Acid	µg/g	1 / 3	1 / 3	33%	1.6	1.6	0.086	0.086	--	--	Undetermined	--	0.086	#	--	[CEB]
bis(2-Ethylhexyl)phthalate	µg/g	2 / 3	2 / 3	67%	0.33	0.33	0.10	0.15	--	--	Undetermined	--	0.15	#	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-113. Summary Statistics and Exposure Point Concentrations for Rabbits at Study Area 10 - Tetryl Manufacturing Area-East
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:41:42 PM
Run Date: 3/29/99
Exposure Unit: 10E_PS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Antimony	µg/g	2 / 3	2 / 3	67%	0.20	0.20	0.19	0.22	--	--	Undetermined	--	0.22	#	1.3	[bk]
Arsenic	µg/g	1 / 3	1 / 3	33%	0.100	0.100	0.13	0.13	--	--	Undetermined	--	0.13	#	--	[CEB]
Calcium	µg/g	3 / 3	3 / 3	100%	--	--	56	85	--	--	Undetermined	--	85	#	6,092	[bk]
Copper	µg/g	3 / 3	3 / 3	100%	--	--	0.52	0.69	--	--	Undetermined	--	0.69	#	--	[CEB]
Iron	µg/g	3 / 3	3 / 3	100%	--	--	7.3	14	--	--	Undetermined	--	14	#	30	[bk]
Magnesium	µg/g	3 / 3	3 / 3	100%	--	--	217	257	--	--	Undetermined	--	257	#	620	[bk]
Potassium	µg/g	3 / 3	3 / 3	100%	--	--	3,070	3,740	--	--	Undetermined	--	3,740	#	7,600	[bk]
Sodium	µg/g	3 / 3	3 / 3	100%	--	--	279	490	--	--	Undetermined	--	490	#	994	[bk]
Zinc	µg/g	2 / 3	2 / 3	67%	11	11	21	21	--	--	Undetermined	--	21	#	28	[bk]
Benzoic Acid	µg/g	2 / 3	2 / 3	67%	1.6	1.6	0.096	0.37	--	--	Undetermined	--	0.37	#	--	[CEB]
bis(2-Ethylhexyl)phthalate	µg/g	3 / 3	3 / 3	100%	--	--	0.086	0.15	--	--	Undetermined	--	0.15	#	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-114. Summary Statistics and Exposure Point Concentrations for Rabbits at Study Area 16 - Flashing Ground
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:47:47 PM
Run Date: 3/29/99
Exposure Unit: 16_PS1

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[g]	Background Comparison[g]
Aluminum	µg/g	2 / 2	2 / 2	100%	--	--	3.1	10	--	--	Undetermined	--	10	#	14	[bk]
Antimony	µg/g	1 / 2	1 / 2	50%	0.99	0.99	0.39	0.39	--	--	Undetermined	--	0.39	#	1.3	[bk]
Barium	µg/g	2 / 2	2 / 2	100%	--	--	1.8	7.0	--	--	Undetermined	--	7.0	#	8.4	[bk]
Calcium	µg/g	2 / 2	2 / 2	100%	--	--	1,700	7,730	--	--	Undetermined	--	7,730	#	6,092	[CEB]
Chromium	µg/g	1 / 2	1 / 2	50%	0.50	0.50	0.61	0.61	--	--	Undetermined	--	0.61	#	--	[CEB]
Copper	µg/g	1 / 2	1 / 2	50%	0.37	0.37	0.50	0.50	--	--	Undetermined	--	0.50	#	--	[CEB]
Iron	µg/g	2 / 2	2 / 2	100%	--	--	17	18	--	--	Undetermined	--	18	#	30	[bk]
Lead	µg/g	1 / 2	1 / 2	50%	0.090	0.090	0.15	0.15	--	--	Undetermined	--	0.15	#	0.20	[bk]
Magnesium	µg/g	2 / 2	2 / 2	100%	--	--	261	366	--	--	Undetermined	--	366	#	620	[bk]
Manganese	µg/g	1 / 2	1 / 2	50%	0.46	0.46	0.81	0.81	--	--	Undetermined	--	0.81	#	--	[CEB]
Nickel	µg/g	2 / 2	2 / 2	100%	--	--	1.4	3.7	--	--	Undetermined	--	3.7	#	2.0	[CEB]
Potassium	µg/g	2 / 2	2 / 2	100%	--	--	2,820	3,250	--	--	Undetermined	--	3,250	#	7,600	[bk]
Selenium	µg/g	1 / 2	1 / 2	50%	0.100	0.100	0.15	0.15	--	--	Undetermined	--	0.15	#	--	[CEB]
Silver	µg/g	2 / 2	2 / 2	100%	--	--	0.40	0.45	--	--	Undetermined	--	0.45	#	--	[CEB]
Sodium	µg/g	2 / 2	2 / 2	100%	--	--	507	554	--	--	Undetermined	--	554	#	994	[bk]
Zinc	µg/g	2 / 2	2 / 2	100%	--	--	16	19	--	--	Undetermined	--	19	#	28	[bk]
Benzoic Acid	µg/g	1 / 2	1 / 2	50%	3.2	3.2	0.52	0.52	--	--	Undetermined	--	0.52	#	--	[CEB]

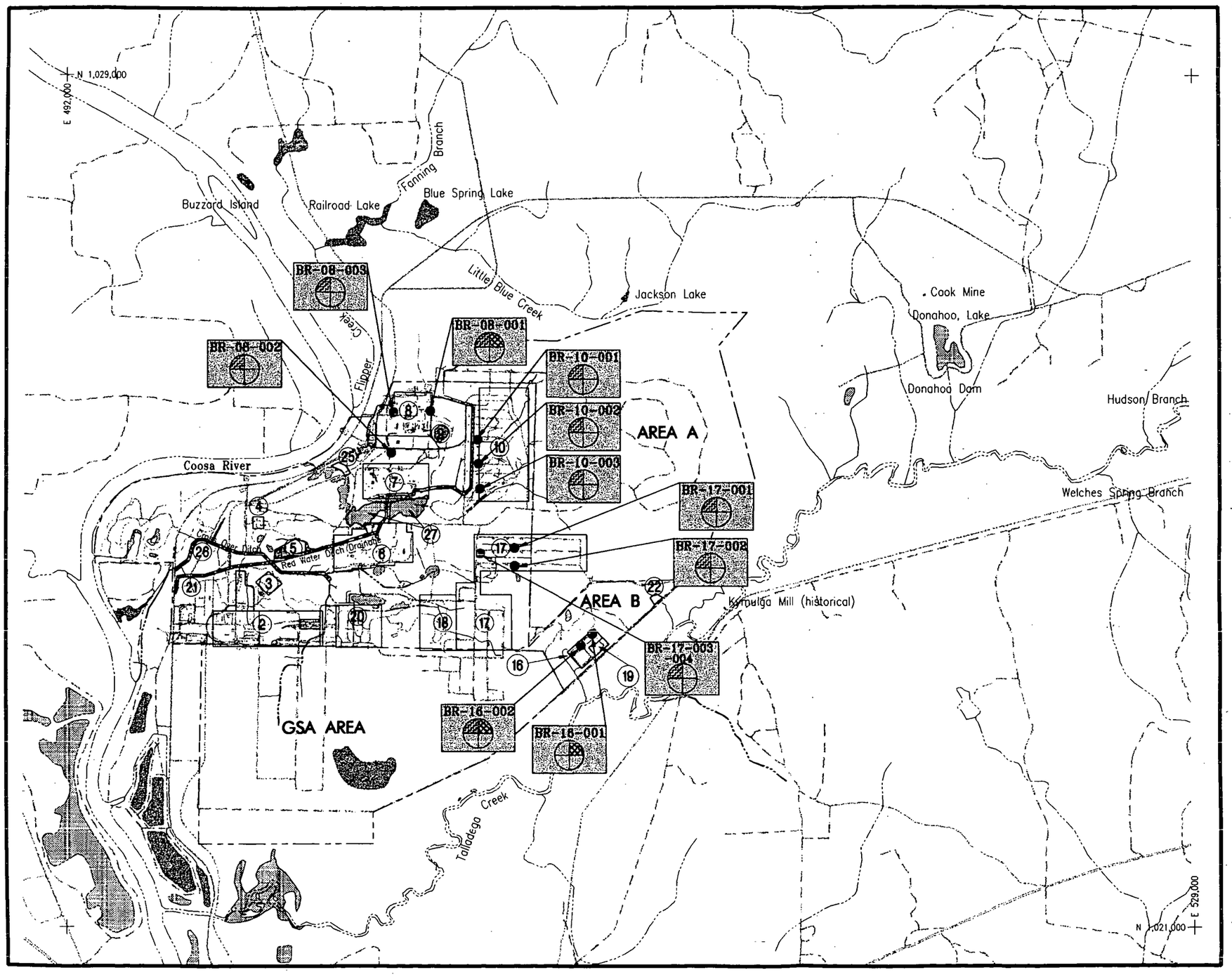
[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC.
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)

Table 4-115. Summary Statistics and Exposure Point Concentrations for Rabbits at Study Area 17 - Propellant Shipping Area
Alabama Army Ammunition Plant, Childersburg, Alabama

Run Time: 5:55:19 PM
Run Date: 3/29/99
Exposure Unit: 17_PSI

Parameter	Units	Proportion of Detects All Samples[a]	Proportion of Detects Temporal & Spatial Samples[b]	Frequency of Detection[b]	NonDetects Min CRL[c]	NonDetects Max CRL[c]	Detects Minimum	Detects Maximum	Arithmetic Mean[d]	Standard Deviation[d]	Distribution[e]	95% UCL of Arith. Mean[d]	Exposure Point Concentration[f]		2 x BK Mean[d]	Background Comparison[g]
Antimony	µg/g	1 / 3	1 / 3	33%	0.20	0.20	0.33	0.33	--	--	Undetermined	--	0.33	#	1.3	[bk]
Arsenic	µg/g	2 / 3	2 / 3	67%	0.100	0.100	0.12	0.25	--	--	Undetermined	--	0.25	#	--	[CEB]
Calcium	µg/g	3 / 3	3 / 3	100%	--	--	38	77	--	--	Undetermined	--	77	#	6,092	[bk]
Copper	µg/g	3 / 3	3 / 3	100%	--	--	1.1	1.2	--	--	Undetermined	--	1.2	#	--	[CEB]
Iron	µg/g	3 / 3	3 / 3	100%	--	--	9.4	14	--	--	Undetermined	--	14	#	30	[bk]
Magnesium	µg/g	3 / 3	3 / 3	100%	--	--	242	269	--	--	Undetermined	--	269	#	620	[bk]
Potassium	µg/g	3 / 3	3 / 3	100%	--	--	3,440	3,740	--	--	Undetermined	--	3,740	#	7,600	[bk]
Sodium	µg/g	3 / 3	3 / 3	100%	--	--	314	515	--	--	Undetermined	--	515	#	994	[bk]
Benzoic Acid	µg/g	2 / 3	2 / 3	67%	1.6	1.6	0.095	0.13	--	--	Undetermined	--	0.13	#	--	[CEB]
bis(2-Ethylhexyl)phthalate	µg/g	3 / 3	3 / 3	100%	--	--	0.092	1.1	--	--	Undetermined	--	1.1	#	--	[CEB]

[a] For the "Proportion of Detects - All Samples" column, counts were based on the unaveraged data set.
[b] For the "Proportion of Detects - Temporal and Spatial Samples" and the "Frequency of Detection" columns, counts were based on the averaged data set (e.g., groundwater samples from the same well were averaged).
[c] CRL - contract reporting limit.
[d] Nondetects were treated as one-half the detection limit in the calculation of the site and background (BK) arithmetic means, standard deviation, and 95% upper confidence limit (UCL).
[e] Distributions for the calculation of exposure point concentrations (EPCs): 1) If fewer than 4 samples are available in the site data set, "Undetermined" is indicated and the 95%UCL is calculated based on a lognormal distribution. 2) If the normal goodness-of-fit test coefficient is greater than the critical value, the distribution is normal. 3) If the lognormal goodness-of-fit test coefficient is greater than the critical value, the distribution is lognormal. 4) If neither of the goodness-of-fit test coefficients is greater than the critical value, the distribution is assumed to be lognormal.
[f] The EPC is the 95% UCL of the arithmetic mean with 2 exceptions: if the 95% UCL exceeds the maximum detected value (denoted by a "#" next to the EPC) or the site data set contains fewer than 4 samples, the maximum detected value is substituted as the EPC
[g] CEB (chemical exceeding background) - the maximum detected result is greater than or equal to two times the background mean; bk (background) - the maximum detected result is less than two times the background mean; ANOVA - analysis of variance determines that the site and background data sets come from the same population.
-- Not applicable (note: background comparison not conducted for organic compounds)



LEGEND:

- BUILDINGS
- PRIMARY ROADS
- SECONDARY ROADS
- TRAILS
- FENCE
- AREA BOUNDARIES
- (27) STUDY AREAS
- RAIL ROAD
- CREEK, TRIBUTARIES AND RIVER
- WETLANDS
- PONDS, IMPOUNDMENTS
- GRID BASED ON ALABAMA STATE PLANE EAST
- RABBIT COLLECTION LOCATION
- BIOTA TISSUE CONFIRMATION SAMPLE

ANALYTICAL GROUPS
SVOCs METALS
PESTICIDES/PCBs EXPLOSIVES

STATE PLANE GRID

0 1750 3500 7000
SCALE: 1" = 3500'

U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

CEBs in Rabbit Tissue at ALAAP

Figure No.	Project No.	File Name	Date
4-60	01-0827-03-8178-045	99015/DWGS/E42PIE18	03-31-99

Selenium was detected in one rabbit sample from Study Area 8 and one from Study Area 16. The selenium concentrations were 0.16 and 0.15 µg/g, respectively.

Elevated metals in rabbit samples from Study Areas 8 and 16 may be related to relatively higher concentrations of some metals in the surface soils at these study areas. Copper concentrations were elevated at both study areas. Arsenic and nickel concentrations in Study Area 8 surface soils also were high relative to background and other study areas. Selenium and silver were not detected in the surface soils at either study area.

Explosives—Explosives were not detected in any of the rabbit samples.

SVOCs—Three SVOCs were detected at low concentrations (predominantly near or below the CRL) in rabbit tissue, as shown in the adjacent box. These SVOCs also were detected in the crayfish and fish samples. 4-Methyl phenol was detected in only one rabbit sample collected from Study Area 8 at a concentration (0.101 µg/g) below the CRL of 0.33 µg/g. B2EHP was detected in 10 rabbit samples at concentrations ranging from 0.086 to 1.09 µg/g, with only one value exceeding the CRL of 0.33 µg/g. The highest concentration of B2EHP was detected in a rabbit sample collected from Study Area 17. Benzoic acid was detected in 6 of the 11 rabbit samples, with concentrations ranging from 0.086 to 0.52 µg/g. All concentrations were below the CRL of 1.6 µg/g for benzoic acid. The highest concentration of benzoic acid was detected in a rabbit sample collected from Study Area 16.

	Maximum Concentrations (µg/g)			
Analyte	Study Area 8	Study Area 10	Study Area 16	Study Area 17
4-Methyl Phenol	0.101			
Benzoic Acid	0.086	0.37	0.52	0.13
B2EHP	0.15	0.15		1.09

Pesticides/PCBs—Pesticides and PCBs were not detected in any of the rabbit samples.

Summary—Seven metals exceeded background in Study Area 16 rabbit samples. Four metals exceeded background in Study Area 8 rabbit samples, and two metals exceeded background in Study Area 10 and 17 rabbit samples. Explosives were not detected in any of the rabbit samples analyzed. Three SVOCs were detected in rabbit samples collected from the study areas, with only B2EHP detected at a concentration above the CRL.

4.8.6 Summary of Biota Results

Explosives were not detected in any of the tissue samples from crayfish, fish, fish fillets, or rabbits collected from ALAAP. Low concentrations (primarily near or below the CRLs) of a number of SVOCs (e.g., B2EHP, 4-methyl phenol, phenol, and benzoic acid) also were detected in tissue samples. The chemicals detected in biota from background locations and at concentrations exceeding background from study areas are shown in **Table 4-116**.

Table 4-116. Chemicals Exceeding Background in Biota
Alabama Army Ammunition Plant, Childersburg, Alabama

Chemicals[a]	Study Area 21	Study Area 26			Study Area 27			Talladega Creek Tributary			Background[b]			Study Area 8	Study Area 10	Study Area 16	Study Area 17	Background[b]
	Fish	Crayfish	Fish	Fish Fillet	Crayfish	Fish	Fish Fillet	Crayfish	Fish	Fish Fillet	Crayfish	Fish	Fish Fillet	Rabbits				
Metals																		
Aluminum	✓	✓			✓	✓			✓		✓	✓	✓					✓
Antimony		✓						✓			✓	✓	✓					✓
Arsenic	✓	✓	✓		✓				✓		✓	✓	✓	✓	✓		✓	
Barium	✓		✓		✓	✓	✓		✓		✓	✓	✓					✓
Beryllium	✓																	
Calcium			✓			✓	✓		✓		✓	✓	✓			✓		✓
Chromium		✓			✓	✓	✓		✓							✓		
Cobalt	✓	✓				✓	✓											
Copper									✓		✓	✓	✓	✓	✓	✓	✓	
Iron	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓					✓
Lead	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓						✓
Magnesium	✓										✓	✓	✓					✓
Manganese	✓	✓	✓		✓	✓	✓		✓		✓	✓	✓			✓		
Mercury		✓	✓	✓	✓							✓	✓					
Nickel		✓				✓	✓	✓						✓		✓		✓
Potassium		✓			✓						✓	✓	✓					✓
Selenium	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		✓		✓		
Silver	✓										✓					✓		
Sodium	✓		✓								✓	✓	✓					✓
Vanadium		✓							✓		✓	✓						
Zinc											✓	✓	✓					✓

a A ✓ in the table indicates that the chemical exceeded background (for metals) or was detected (for organics)
b Chemicals that were present in biota from background locations

Table 4-116. Chemicals Exceeding Background in Biota
Alabama Army Ammunition Plant, Childersburg, Alabama (Continued)

	Study Area 21	Study Area 26			Study Area 27			Talladega Creek Tributary			Background[b]			Study Area 8	Study Area 10	Study Area 16	Study Area 17	Background[b]
SVOCs	Fish	Crayfish	Fish	Fish Fillet	Crayfish	Fish	Fish Fillet	Crayfish	Fish	Fish Fillet	Crayfish	Fish	Fish Fillet	Rabbits				
2-methylnaphthalene									✓	✓								
4-methyl phenol		✓	✓		✓	✓			✓	✓		✓		✓				
Benzoic acid	✓	✓	✓			✓						✓		✓	✓	✓	✓	
Benzyl alcohol	✓		✓			✓	✓											
B2EHP		✓							✓	✓		✓	✓	✓	✓		✓	
Naphthalene/ tar camphor									✓									
Phenol/carbolic acid/ hydroxybenzene		✓	✓		✓			✓										
PCBs																		
Aroclor-1254	✓																	
Pesticide																		
4,4'-DDE	✓		✓			✓			✓			✓	✓					
4,4'-DDT			✓									✓						
Aldrin									✓			✓						
Beta-BHC	✓		✓						✓			✓						
Endrin aldehyde			✓						✓			✓						
Heptachlor	✓					✓												
Heptachlor epoxide									✓									
Lindane									✓									

a A ✓ in the table indicates that the chemical exceeded background (for metals) or was detected (for organics)
b Chemicals that were present in biota from background locations

Fourteen metals were detected in crayfish at concentrations exceeding background. The highest concentrations of metals were detected in crayfish from the lower end of the Crossover Ditch (Study Area 26) near the western edge of the installation. Four SVOCs were detected in crayfish, and the highest concentrations of these SVOCs also were detected in the Crossover Ditch.

Eighteen metals were identified as CEBs in fish samples. Fish collected from the Red Water Ditch (Study Area 21) contained the highest concentrations of five of the CEB metals. The Crossover Ditch fish samples contained the highest concentrations of four of these metals, as did the samples from the Talladega Creek tributary. There were five CEB metals detected at maximum concentrations in fish collected from the Beaver Pond Drainage System (Study Area 27).

Seven SVOCs were detected in fish. Of these, three (4-methyl phenol, B2EHP, and benzoic acid) also were detected in the fish collected at background locations. Aroclor-1254 was detected only at Study Area 21 in three of the five fish samples analyzed. Eight pesticides were detected in the fish tissue samples. Five pesticides also were detected in background fish tissues.

Ten metals were identified at concentrations that exceeded background in fish fillets. Eight metals exceeded background in fillet samples from the Beaver Pond Drainage System (Study Area 27), while only three and two metals exceeded background at the Crossover Ditch and Talladega Creek tributary, respectively. Only one SVOC, 4-methyl phenol, was detected at a concentration above the CRL in a fish fillet from the Talladega Creek tributary. PCBs, pesticides, and explosives were not detected in fish fillet samples. One pesticide, 4-4'-DDE (0.0043 μg/g) and one SVOC, B2EHP (0.162 to 0.304 μg/g) were detected in the background fish fillets.

Eight metals were detected at concentrations exceeding background in rabbit samples. Copper was detected in rabbit samples from all four locations, and arsenic was detected in samples from three locations. All other CEB metals were detected as CEBs in samples from only one or two study areas. B2EHP was the only SVOC detected in rabbit tissue at a concentration above the CRL. Explosives, pesticides, and PCBs were not detected in any of the rabbit samples. Metals were detected in background rabbit tissue samples.

5. CHEMICAL FATE AND TRANSPORT

The physical and chemical properties of the detected chemical constituents in environmental media underlying the Alabama Army Ammunition Plant (ALAAP) facility are described below. Potential migration pathways and mechanisms for the transformation and transport of the chemical substances in the natural environment are summarized within the framework of a conceptual site model (CSM). The rate of chemical migration through soil and groundwater to potential receptor locations is estimated based on the concentration and chemical properties of the detected constituents and the physical properties of the site and the underlying aquifer.

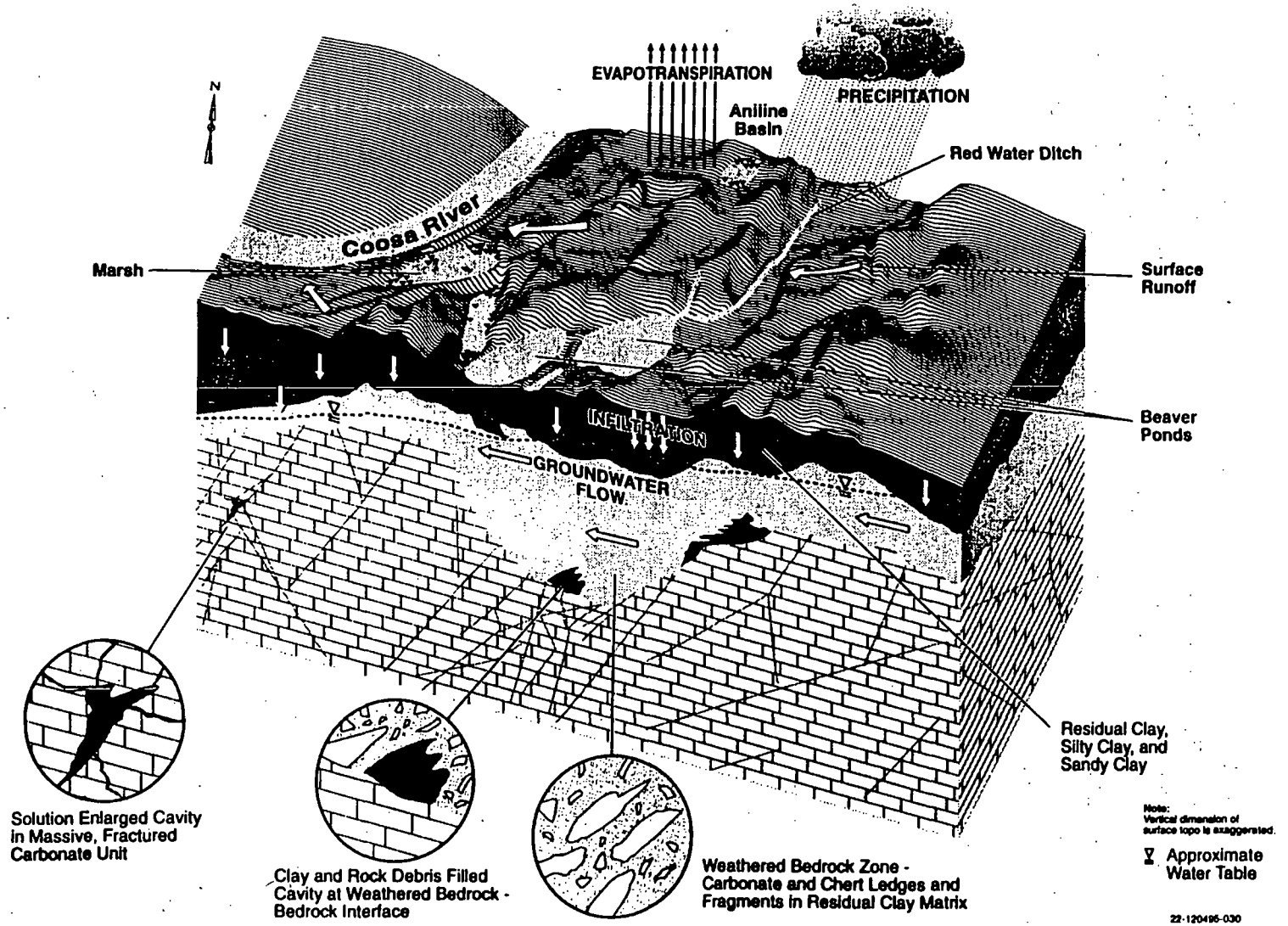
5.1 CONCEPTUAL SITE MODEL

A CSM is a statement of known or expected site conditions that serve as a framework within which an investigation is developed and against which new data can be compared and interpreted. The predictive function of the CSM, of primary importance to chemical fate and transport analyses, relies on known information and informed assumptions about the site. A CSM for ALAAP is shown in **Figure 5-1** and includes the following components:

- ***Infiltration and Surface Runoff***—The potential for contaminant transport begins with precipitation. The degree to which the processes of infiltration and runoff occur across ALAAP is variable and dependent on the density of vegetation and soil hydraulic conductivity. Because of dense vegetation on ALAAP, the amount of infiltration is expected to be high because of extensive rooting activity, which creates vertical pathways. Approximately 19 percent of the average annual precipitation, or an annualized average of 530,000 gpd/mi^2, is estimated to infiltrate to groundwater at ALAAP. In areas where vegetation is less dense or absent (e.g., along unpaved roads, ditches, and portions of clear cut areas), the amount of surface runoff is expected to be high. Approximately 28 percent of the average annual precipitation at the site is estimated as surface runoff.

- ***Evapotranspiration***—A percentage of infiltrated water does not recharge to groundwater and is lost from the subsurface via evapotranspiration. The amount of evapotranspiration loss is variable and depends on the extent and type of vegetative cover and the ambient air temperature. Based on site conditions at ALAAP, a large percentage (53 percent) of the average annual precipitation is estimated to be lost to evapotranspiration.

- ***Surface Flow***—Surface water flow on ALAAP occurs through intermittently flowing, man-made and natural drainage channels on the facility. Because flow in the streams is ephemeral and commonly low, surface water hydrographs are not available. Ponds developed on ALAAP are the result of interrupted flow (dam construction by beavers) in the surface streams. The Beaver Ponds were not observed to significantly recharge in the absence of precipitation or spring flow.



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CHILDERSBURG, ALABAMA

Conceptual Site Model

Figure No.	Project No.	File Name	Date
5-1	01-0827-03-8178-045	99015\DWGS\E42F5-1	03-31-99

- ***Subsurface Flow System***—Water that is not lost to evapotranspiration or surface runoff infiltrates into the subsurface flow regime. The groundwater system includes the partially saturated vadose zone and the saturated zone below the water table. Soils underlying ALAAP consist of silty and clayey residuum with thickness ranging between approximately 5 and 121 feet. The bedrock underlying the site consists of limestone and dolomite with an undulating surface that reflects variable weathering at the site and slopes from east to west toward the Coosa River. Typical of karst aquifers, many voids occur in the residuum and the bedrock that range from 1 to 40 feet in vertical extent. Because of the contrast in hydraulic conductivity between the soil and rock, the soil/bedrock interface underlying the site area is variably saturated, even above the water table, and provides an enhanced pathway for groundwater movement at the site. Preferential groundwater flow pathways have developed in the karst aquifer and potentially capture a large proportion of the groundwater flow. Overall, groundwater flow beneath ALAAP is predominantly to the northwest toward the Coosa River with discharge to surface water drainage in Area B, particularly in the vicinity of the Beaver Ponds and the Crossover Ditch. A groundwater divide coincident with a topographic (and bedrock) ridge occurs in the eastern portion of Area B.

5.1.1 Release Mechanisms

Potential release mechanisms at ALAAP include precipitation infiltration with leaching to groundwater, surface runoff, and gaseous or airborne particulate emission. Precipitation that does not leave the site as surface runoff or evapotranspiration infiltrates into the subsurface. The rate of percolation is controlled by soil cover, ground slope, saturated conductivity of the soil, and the presence of macropores in the variably saturated residuum. Water infiltrating through contaminated surface and subsurface soil may take soluble chemicals into solution with transport to the underlying groundwater. Factors that affect the leaching rate include the chemical concentration, chemical solubility, soil/water partition coefficient (K_d), pH conditions, and volume of infiltration. The organic compounds detected at ALAAP are generally soluble in the natural environment, and therefore, sorption processes, governed by the K_d value, will have the greatest effect on leaching. Those contaminants with small K_d values will be leached more effectively than those with larger K_d values. The presence of acidic precipitation and humic or fulvic acids in the variably saturated zone may act to enhance the leaching of soluble chemicals in the soil.

Contaminants that are adsorbed onto surface soils can be released by desorption into surface runoff or may be entrained with particulate matter by soil erosion during a rainstorm. Significant surface runoff and erosion at ALAAP will be limited to those areas that are more sparsely vegetated. Specific areas or features at ALAAP where surface runoff and erosion may be significant include previous cut and fill areas that were produced as a result of remediation activities that have occurred during the past several years. These areas include Study Areas 16, 19, 21, and 22.

Organic compounds with high vapor pressures in surface soil are released through volatilization. The rate of emission is controlled by the combined vapor pressure of the organic

compounds and decreases rapidly over a short period of time as the volatiles are depleted. Volatile organic compounds (VOCs) in the subsurface soils are emitted to the atmosphere via vertical diffusion through soil pores. Depending on subsurface concentration, chemical volatility, and the extent to which diffusion has occurred, gaseous emissions from subsurface soils may be significant. However, based on the low detected concentrations of VOCs in the ALAAP soils, volatilization is not expected to be an important transport mechanism at the site.

Particulate matter from contaminated surface soil can become airborne as a result of wind erosion. This process is controlled by vegetative cover, wind speed, moisture, and other fluids in the surface soils. Because the majority of the area at ALAAP is vegetated, the potential for wind erosion is minimal under current conditions. A larger potential for dust generation occurred during previous site remediation or construction activities.

5.2 PHYSICAL AND CHEMICAL PROPERTIES

The migration of chemical constituents through the subsurface soils and groundwater is governed by the physical and chemical properties of the detected chemicals and the subsurface media through which the chemicals are transferred. In a general way, chemical constituents and structures with similar physical and chemical characteristics will show similar patterns of transformation, transport, or attenuation in the environment. Solubility, vapor pressure data, chemical partition coefficients, degradation rates, and Henry's Law activity provide information that can be used to evaluate contaminant mobility in the environment. Partition coefficients are used to assess the relative affinities of compounds for solution or solid phase adsorption. However, the synergistic effects of multiple migrating compounds and the complexity of soil/water interactions, including pH and oxidation-reduction potential (Eh), grain size, and clay mineral variability, are typically unknown. In a similar manner, the characteristics of the physical environment through which vapor and fluid transport are occurring is known in only a discretized detail with inferences between known data point locations. The relevance of the physical and chemical properties affecting chemical migration is discussed below.

5.2.1 Aquifer Properties

The aquifer underlying ALAAP consists of fine-grained silt and clay residuum derived from the in situ weathering of carbonate bedrock. Relict structures, including bedding, joints, fractures, and subsurface voids, are variably retained in the developed residuum. The physical properties of the aquifer control the ability of dissolved chemical constituents to migrate in the subsurface. Saturated horizontal hydraulic conductivity values obtained from aquifer (slug) testing on ALAAP are lognormally distributed with a geometric mean of 3.62×10^{-4} cm/sec (1.03 feet/day) and a range between 1.472×10^{-6} cm/sec (0.004 feet/day) and 7.6×10^{-1} cm/sec (2.154 feet/day). The observed variability in the residuum measured at the site is directly related to the geological structures, lithology, and the presence of discontinuities (i.e., fractures, voids, and joints) inherent in the karst geology. Based on the average flow conditions across Area B, the average groundwater velocity is calculated as 0.014 feet/day; however, higher flow rates, possibly exceeding 30 feet/day, would be

associated with higher hydraulic conductivity pathways. Aquifer porosity at the site may vary from 0.1 for slightly fractured bedrock to 1.0 in unfilled, interconnected void space. The geometric mean hydraulic conductivity (1.092×10^{-3} cm/sec) measured in wells screened in bedrock was approximately three times the mean in the residuum.

5.2.2 Chemical Properties

The physical properties of the chemical constituents that were detected in the environmental media at ALAAP are summarized in **Table 5-1**. The properties are used to assess the anticipated behavior of each compound under environmental conditions.

The water solubility of a compound is a measure of the saturated concentration of the compound in water at a given temperature and pressure. The tendency for a compound to be transported by groundwater is directly related to its solubility and inversely related to both its tendency to adsorb to soil and to volatilize from water (OGE 1988). Compounds with high water solubilities tend to desorb from soils and sediments, are less likely to volatilize from water, and are susceptible to biodegradation. The water solubility of a compound varies with temperature, pH, and the presence of other dissolved constituents (including organic carbon and humic acids).

The octanol-water partition coefficient (K_{ow}) is a laboratory-determined ratio of the concentration of a chemical in the n-octanol phase of a two-phase system to the concentration in the water phase. The octanol-water partition coefficient can be used to estimate the tendency for a chemical to partition between environmental phases of different polarity. Compounds with log K_{ow} values less than 1 are highly hydrophilic, while compounds with log K_{ow} values greater than 4 will partition to soil particles (Lyman et al. 1982).

The soil adsorption coefficient (K_{oc}) is a measure of the tendency of a compound to partition between soil and water. The K_{oc} is defined as the ratio of the adsorbed compound per unit weight of organic carbon to the aqueous solute concentration. This coefficient can be used to estimate the degree to which a compound will adsorb to soil and thus not migrate with groundwater. The higher the K_{oc} value, the greater the tendency of the compound to partition into soil (OGE 1988). The K_d is calculated from the K_{oc} coefficient by multiplying the K_{oc} value by the fraction of organic carbon in the soil.

Vapor pressure is a measure of the pressure at which a compound and its vapor are in equilibrium. The value can be used to determine the extent to which a compound would travel in air, as well as the rate of volatilization from soils and solution (OGE 1988). In general, compounds with vapor pressures lower than 10^{-7} mm Hg will not be present in the atmosphere or soil air in significant amounts, while compounds with vapor pressures higher than 10^{-2} mm Hg will exist primarily in the air (Dragun 1988). As Table 5-1 shows, VOCs will exist primarily in the atmosphere and soil air, while pesticides and other semivolatile organic compounds (SVOCs) will exist in both the air and the soil.

Table 5-1. Physical and Chemical Properties of Organic Constituents Detected in Soil/Groundwater Alabama Army Ammunition Plant, Childersburg, Alabama

Chemical	Molecular Weight	Solubility S_w (mg/L)	S_w @ Temp. (°C)	K_{ow} (ml/ml)	Henry's Constant (K_H) (atm.m³/mol)	K_H @ Temp. (°C)	Air Diffusion Coefficient (cm²/s)		K_{oc} (ml/g)	Biodegradation Rate l (1/day)	Biodegradation half-life (day)
Volatile Organic Compounds											
2-Butanone	72.1	275000		2	6.61E-07	25#	0.092	s	1	2.48E-02	28
Acetone	58.1	1000000		1	5.14E-07	25#	0.110	s	0.36	2.48E-02	28
Carbon disulfide	76.1	2900	20	145	2.94E-04	25#	0.105	s	91		
Carbon Tetrachloride	153.8	800	20	537	2.93E-02	25	0.082	s	338	1.93E-03	360
Chloroform	119.4	9300	25	93	3.39E-03	25	0.091	s	59	3.85E-04	1800
Methylene chloride	84.9	16700	25	18	3.19E-03	25	0.104	s	11	6.19E-03	112
Toluene	92.1	515	20	490	5.92E-03	25	0.085	s	309	3.30E-03	210
Semivolatile Organic Compounds											
Benzo (a) anthracene	228.3	0.01	24	407380	2.94E-08	25#	0.051		256650	2.55E-04	2721
Benzo (a) pyrene	252.3	0.0038	25	954993	4.90E-07	25	0.043		601645	3.27E-04	2121
Benzo (b) fluoranthene	252.3	0.001	#	3715352	2.94E-07	25#	0.044	#	2340672	2.84E-04	2442
Bis-(2-Ethylhexyl)phthalate	390.6	1.3	25	199526	3.00E-07	20	0.032	s	125702	1.78E-03	389
Carbon disulfide	76.1	2900	20	145	2.94E-04	25#	0.105	s	91		
Chrysene	228.3	0.006	25	407380	1.05E-06	25	0.046		256650	1.73E-04	4000
Dibenzofuran	168.2	10		13183			0.068		8305	6.18E-03	112
Dibenzo(a,h)anthracene	278.4	0.0005	25	933254	7.30E-08	25	0.042		587950	1.84E-04	3758
Ideno (1,2,3-cd) pyrene	276.3	0.0001		45708819	6.95E-08	25	0.044		28796556	2.37E-04	2921
N-nitroso-diphenylamine	198.2	35		617	4.72E-03	25w	0.060		388	5.10E-03	136
Pyrene	202.3	0.16	26	151356	5.10E-06	25	0.051		95354	9.14E-05	7583
Explosives											
1,3,5-Trinitrobenzene (TNB)	213.1	350		15	2.21E-09		0.241*		10	NA	NA
1,3-Dinitrobenzene (DNB)	168.1	469	15	31	5.80E-08	#	0.271*		19	1.93E-03	360
2,4-Dinitrotoluene (2,4-DNT)	182.1	270	22	102	8.67E-07	#	0.203		64	1.93E-03	360
2,4,6-Trinitrotoluene (TNT)	227.1	100	25	338844	2.00E-07		0.187*		213472	1.93E-03	360
2,6-Dinitrotoluene (2,6-DNT)	182.1	270	22	112	2.17E-07	#	0.203		71	1.93E-03	360
o-Nitrotoluene (O-NT)	137.1	442	32	234	4.00E-04		0.234		147	NA	NA

Solubilities, Henry's Constant and Log (Kow) have been taken from RREL Treatability Data Base (EPA 1994) except otherwise indicated.
Biodegradation half-lives are taken from Hand Book of Environmental Degradation Rates (Howard et. al. 1990) except otherwise indicated.
Air diffusion coefficients are obtained from EPA 1987, except otherwise indicated.
[#] - indicates STF Data Base (EPA 1992) as the source
[w] - EPA WATER7 database November 1990
[s] - indicates Shen et. al 1993 as the source
K_{ow} = Octanol-water partition coefficient
K_{oc}=Organic carbon partition coefficient

The Henry's Law constant value (K_H) for a compound is a measure of the ratio of the compound's vapor pressure to its aqueous solubility. The K_H value can be used to make general predictions about the compound's tendency to volatilize from water. Substances with K_H values less than 10^{-7} atm•m^3/mol generally will volatilize slowly, while compounds with K_H values greater than 10^{-3} atm•m^3/mol will volatilize rapidly (Lyman et al. 1982).

Organic chemicals with differing chemical structures will biodegrade at different rates. Primary biodegradation consists of any biologically induced structural change in an organic chemical, while complete biodegradation is the biologically mediated degradation of an organic compound into carbon dioxide, water, oxygen, and other metabolic inorganic products (Dragun 1988). The biodegradation rate of an organic chemical is proportional to the concentration:

$$-\Delta C / \Delta t = kC^n$$

Where:

C = Concentration
k = Biodegradation rate constant = (2.303/t) log (a/[a-x])
t = Time
a = Initial concentration
n = Reaction order.

The half-life ($t_{1/2}$ = 0.693/k) is the time necessary for half of the chemical concentration to react. The biodegradation rate of an organic chemical generally is dependent on the presence and population size of soil microorganisms capable of degrading the chemical.

5.3 ENVIRONMENTAL FATE

Inorganic and organic constituents in soil, sediment, and groundwater are in continuous chemical and physical interaction with ambient surface and subsurface environmental conditions. The observed distributions of chemical concentrations in the environment are affected by these interactions and determine the chemical fate of these materials in the various media. Chemicals released into the environment are susceptible to several degradation pathways, including hydrolysis, oxidation, reduction, isomerization, photolysis, photo-oxidation, biotransformation, and biodegradation. Transformation products resulting from these processes will behave distinctively in the environment.

5.3.1 Metals

Inorganic constituents detected in soil and sediment samples at ALAAP are associated with both the aqueous phase (unbound pore water) and leachable metal ions on soil particles. The transport of these materials from unsaturated soils to the underlying groundwater is controlled by the physical processes of precipitation infiltration, chemical interaction with the soil, and downward

transport of removed metal ions by continued infiltration. The additional physical mechanism of erosive transport is important for surface soil and sediment dispersal. The chemistry of inorganic interaction with percolating precipitation and varying soil conditions is complex and includes numerous chemical transformations that may result in altered oxidation states, ion exchange, adsorption, precipitation, or complexation. The chemical reactions, which are affected by environmental conditions including pH, oxidation/reduction conditions, and the type and amount of organic matter, clay, and the presence of hydrous oxides, may act to enhance or reduce the mobility and toxicity of the metal ions. In general, these reactions are reversible and add to the variability commonly observed in inorganics distributions in soil and sediment.

Inorganic chemical form impacts the solubility and mobility in the environment; however, chemical speciation is complex and difficult to delineate in routine laboratory analysis. Metals in soil and sediment commonly are found in several forms (Shuman 1991), including:

- Dissolved concentrations in soil pore water
- Metal ions occupying exchange sites on inorganic soil constituents
- Specifically adsorbed metal ions on inorganic soil constituents
- Metal ions associated with insoluble organic matter
- Precipitated inorganic compounds as pure or mixed solids
- Metal ions present in the structure of primary or secondary minerals.

In situations where metal ions have been introduced to the environment by human activities, they are attributed to non-mineralogic occurrences. The dissolved (aqueous) fraction and its equilibrium fraction are of primary importance when considering the migration potential of metals associated with soil and sediment. Of the inorganic compounds that are likely to form, chlorides, nitrates, and nitrites are commonly the most soluble. Sulfate, carbonate, and hydroxides generally have low to moderate solubility. Soluble compounds are transported in aqueous form subject to attenuation, whereas less soluble compounds remain as a precipitate and limit the overall dissolution of the metal ions. The solubility of the metal ions also is regulated by ambient chemical conditions, including pH and oxidation/reduction.

As a first approximation, the attenuation of metal ions in the environment can be estimated numerically using the retardation factor (R_d). The extent to which the velocity of the contaminant is slowed is largely derived from the K_d and is expressed by the following relation:

$$R_d = 1 + K_d * \rho_b / \theta$$

Where:

ρ_b = Soil bulk density (g/cm^3)
θ = Soil moisture content
K_d = Soil/water partition coefficient.

Table 5-2 provides a range of K_d values for metal ions concentrations in various soil types. Because of variability in the media and in the methods of measurement, the reported K_d values for metal ions vary over orders of magnitude and may similarly vary between samples. The use of the K_d approach for estimating metal ion transport does not take into account the processes of soil diffusion, precipitation, dissolution, and complexation and, as a result, provides only an initial estimate of environmental fate. Metals concentrations may be biotransformed or bioconcentrated through microbial activity.

5.3.2 Organic Compounds

The predominant organic chemical compounds detected in the ALAAP soils include explosives-related compounds and SVOCs. These compounds may be transformed or degraded in the environment by various processes, including hydrolysis, oxidation/reduction, photolysis, volatilization, biodegradation, or biotransformation. The half-life (time required to naturally reduce chemical concentration by one-half) of organic compounds in various media can vary from minutes to years depending on environmental conditions and the chemical structures of the compounds. Organic degradation may either enhance (through the production of more toxic byproducts) or reduce (through concentration reduction) the toxicity of a chemical in the environment. Biodegradation rates (Howard et al. 1991) for the compounds of concern at ALAAP are provided in Table 5-1.

5.3.2.1 Explosives-related Compounds

Explosives-related (nitroaromatic) compounds detected at ALAAP include 2,4,6-trinitrotoluene (TNT), 2,4-dinitrotoluene (2,4-DNT), 2,6-dinitrotoluene (2,6-DNT), 1,3,5-trinitrobenzene (1,3,5-TNB), 1,3-dinitrobenzene (1,3-DNB), and o-nitrotoluene. A major source for the release of munitions-related compounds to the environment is through the discharge of waste streams generated during manufacturing. The concentrations of these compounds in the wastewaters can vary widely depending on the intensity of manufacturing and the availability and efficiency of treatment systems (Burrows et al. 1989). Numerous nitroaromatic byproducts are formed during the manufacture of TNT that enter the effluents as plant cleanup and scrubber wastes, and as condensates from the evaporative concentration of "red waters" or selliting wastes. Soil or sediment contamination by munitions-related compounds occurs from open-burning, operational spills or burials, and seepage from landfills and wastewater holding areas.

Microbiological and photochemical transformations are the two processes affecting the fate and distribution of munitions-related constituents in the environment. The additional chemical processes of oxidation/reduction and hydrolysis have not been observed to be important transformation mechanisms under environmental conditions, with the possible exception of the slow hydrolysis of tetryl. Based on the results of culture studies involving the removal of TNT by activated sludge microorganisms, TNT has been concluded to undergo biotransformation but not

Table 5-2. Summary of Soil/Water Partitioning Coefficients (K_d) for Inorganic Chemical Constituents Alabama Army Ammunition Plant, Childersburg, Alabama

Metal	Sandy Soil (mL/kg)		Loam Soil (mL/kg)		Soils and Clays (Dragun 1988) Minimum[b]	Maximum[b] (mL/g)	Average[b]	Standard Deviation[b]
Aluminum	1500	c	1500	c	NR	NR	NR	NR
Antimony	45	a	150	a	NR	NR	NR	NR
Arsenic	.3-200	d,c	3-200	d,c	1.0	18	4.7	1.73
Barium	5-60	d,c	50-60	d,c	NR	NR	NR	NR
Beryllium	250	a	800	a	NR	NR	NR	NR
Cadmium	2.7-625	a	7-962	a	1.3	27	6.7	2.46
Chromium	0.4-1730	d,a	2.2-1000	a	470	150000	2208	3.32
Hexavalent Chromium					1.2	1800	36.6	9.02
Copper					1.4	333	22.2	3
Lead	10-1410	a	100-59000	d,a	4.5	7640	99.5	5.5
Manganese	6.4-5000	a	40-77000	a	0.2	10000	148	14.9
Mercury	10-10000	c,e	10-10000	c,e	NR	NR	NR	NR
Molybdenum	1.0-52	a	125	a	0.4	400	20	8.2
Nickel	60-3600	a	300	a	NR	NR	NR	NR
Thallium					2000	510000	59874	4.5
Vanadium	1000	c	1000	c	NR	NR	NR	NR
Zinc	0.1-8000	a	3.6-11000	a	0.1	8000	16.5	6.69

a Sheppard and Thibault 1990
b Dragun 1988
c Baes et al 1984
d Gilbert et al 1989
e Looney et al 1987
NR=Not reported

biodegradation (Burrows et al. 1989). Photochemical transformations resulting from the effects of sunlight on explosives compounds are regarded as more important than microbiological transformations because of faster transformation rates.

TNT is readily biotransformed in the environment to amino, diamino, and azoxy compounds (Walsh 1990). It has been found (Funk et al. 1993) that the anaerobic metabolism occurs in two stages. The first stage is the reductive stage in which TNT is reduced to its amino derivatives. In the second stage, degradation to nonaromatic products begins after the reduction of the third nitro group. The biotransformation pathway for TNT in simulated composting systems proposed by Kaplan and Kaplan (1982a) is shown in **Figure 5-2**.

The biotransformation of 2,4-DNT has been studied systematically in laboratory cell cultures. The pathway proposed for this biotransformation is shown in **Figure 5-3**. The reduction products include the amino and azoxy derivatives as observed with TNT biotransformation. As with TNT and DNT, the principal mode of microbial transformation of the nitroaromatic compounds TNB and DNB is reduction of nitro groups to form amino groups.

5.4 CHEMICAL SOURCES, TRANSPORT, AND POTENTIAL RECEPTORS

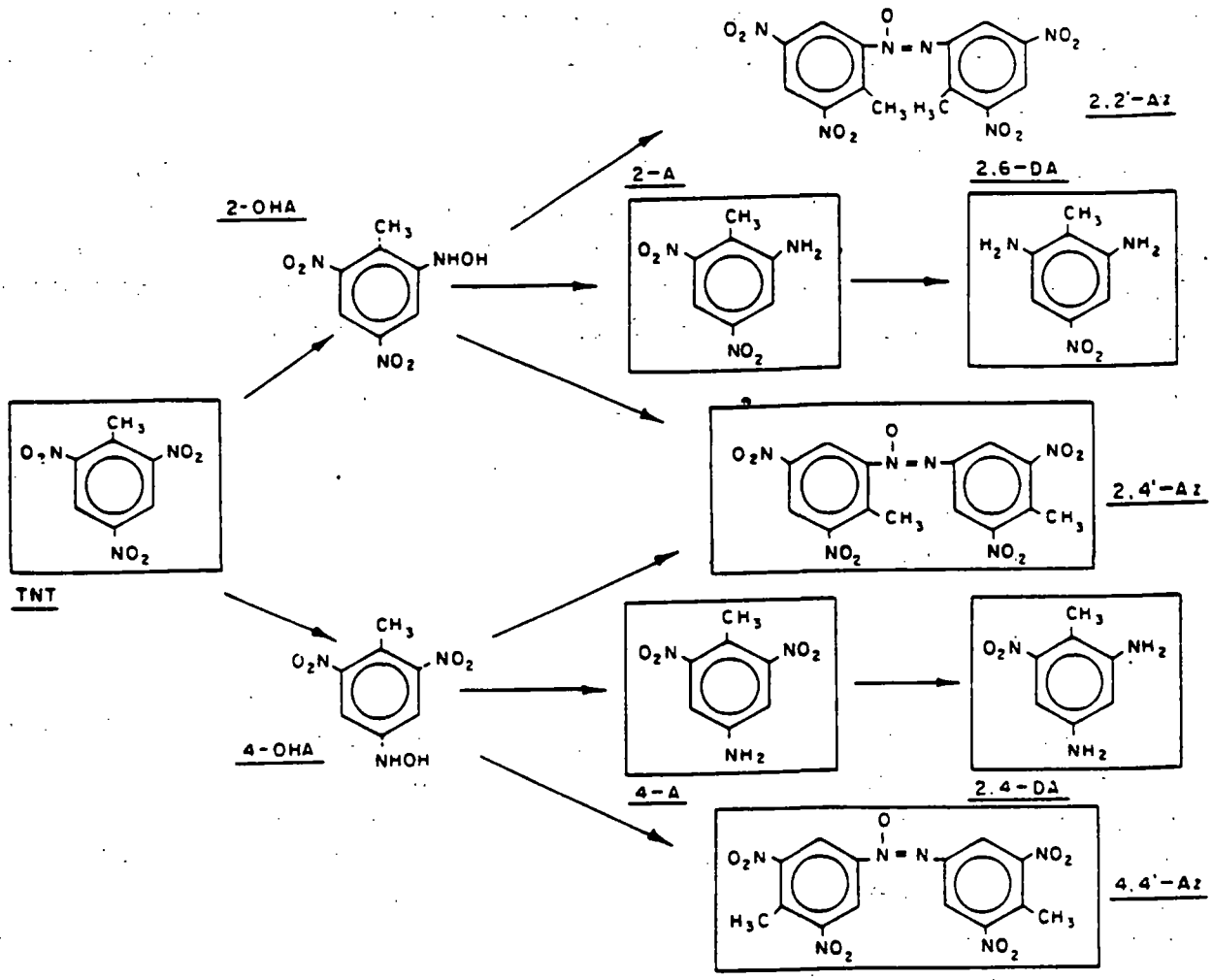
Chemical transport from the affected media from soil and groundwater in ALAAP – Area B is estimated using analytical modeling to evaluate the potential for constituent migration to groundwater and to estimate concentrations at the locations of potential receptors.

5.4.1 Chemical Sources

Sources of environmental contamination on ALAAP occur within several study areas as discrete areas of elevated explosives and metals concentrations in surface and subsurface soils. Groundwater contamination by explosives, metals, and SVOCs generally extends beyond study area boundaries as a broad area of elevated explosives and lead concentrations occurring approximately between Study Areas 6, 18, and 20. Localized areas of elevated explosives and lead concentrations in groundwater are associated with isolated wells or well clusters near Study Areas 2, 8, and 10. The precise sources of these observed concentrations are not known; however, the nature of the chemicals indicates that multiple source areas are present on ALAAP.

5.4.2 Potential Receptors

The entirety of Area B on ALAAP is inactive and is overseen by a caretaker who is responsible for controlling access to the facility. Areas adjacent to Area B include a paper manufacturing facility occupying former ALAAP property to the south of Area B, and Area A, which is a privately owned game preserve that also occupies former ALAAP property. Population centers in immediate proximity to ALAAP occur approximately 1 mile north of the ALAAP boundary (town of Laniers), approximately 0.5 to 2 miles southeast of the Flashing Ground



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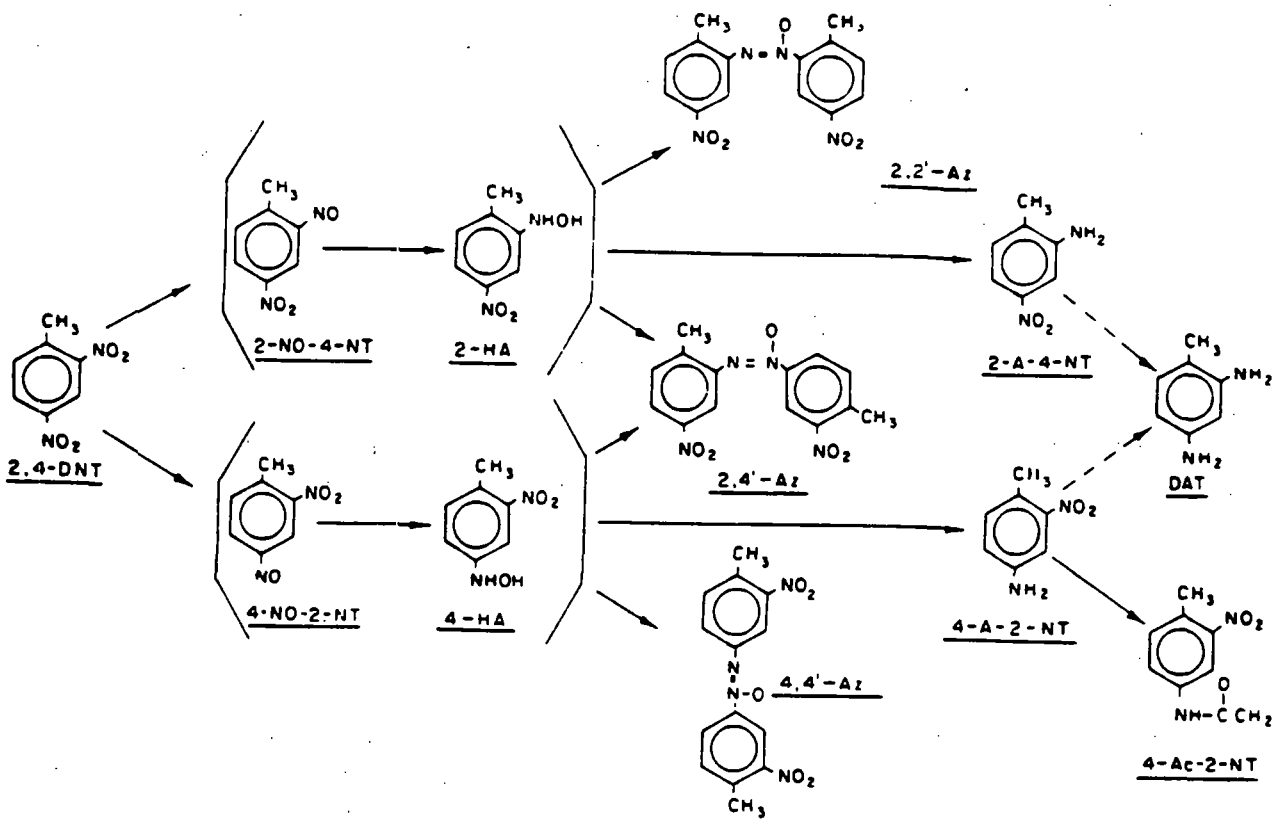
Biotransformation Pathway for TNT

Figure No.	Project No.	File Name	Date
5-2	01-0827-03-8178-045	99015\DWGS\E42F5-2	03-31-99



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Biotransformation Pathway for 2,4 - DNT

Figure No.	Project No.	File Name	Date
5-3	01-0827-03-8178-045	99015\DWGS\E42F5-3	03-31-99

(Study Area 16) and the Lead Facility (Study Area 19) (town of Kymulga), and 1.5 to 2.25 miles from the southern ALAAP boundary. A total of 140 residences or structures were identified within an 18-square mile area adjacent to the ALAAP boundary (ESE 1986). Six private, municipal, or industrial groundwater wells were identified within approximately 0.25 to 2 miles of the present ALAAP boundary (ESE 1993).

Potential receptors of chemical releases from ALAAP include domestic, municipal, or industrial wells, springs, and cisterns located hydraulically downgradient (west/northwest) from ALAAP. Influent surface water bodies, including streams, ponds, lakes, and rivers, also are potential receptors of contaminated groundwater. The Coosa River receives groundwater discharge from ALAAP along the reaches of the river that are adjacent to the facility boundary. Surface water intakes drawing water from the Coosa River potentially may obtain surface water that has mixed with (and significantly diluted) discharging groundwater from ALAAP.

5.4.3 Analytical Modeling Procedures

Analytical models were used to evaluate the potential for inorganic and organic chemical constituents to leach from site soils to groundwater and for transport by groundwater. The inherent problems associated with modeling the leaching of chemical constituents from site soils must be recognized. The equilibrium distribution coefficient (K_d) values that primarily govern the partition between the liquid and solid phases are highly sensitive to changes in the physical composition and major chemistry of these phases. Projected organic concentrations in the aquifer are highly uncertain because of the lack of site-specific data for constituent decay in the vadose zone. Use of literature values may either over- or underestimate the concentrations of constituents in the aquifer.

Along with the uncertainty in the estimation of the partitioning parameters, several other factors could contribute to the discrepancy between the chemical concentrations measured in the field and the values predicted by a model. First is the inability of the model to account realistically for the initial areal distribution of the chemicals in the soil. Second, existing groundwater contamination at the site is the result of years of residual leaching. Soil concentration data are not available for these pre-existing conditions. Therefore, it is unlikely that groundwater concentrations currently observed can be attributed solely to presently observed soil concentrations.

Soil leaching estimates were made using the Summers (Summers et al. 1980) analytical transport model evaluated over a range of K_d values and areas of contamination and using average aquifer properties. The model equation uses a mass balance approach to estimate the chemical concentration that would be expected in groundwater based on leaching of constituents from the soil matrix. The concentration of a chemical in groundwater is a function of the amount of chemical infiltrating through a theoretical soil column of negligible thickness to the aquifer and the initial chemical concentration in the aquifer. The chemical concentration also is determined by the volume of water into which the leachate is dissolved. The Summers model incorporates the physical and chemical characteristics of the contaminants and the characteristics of the receiving aquifer to

simulate contaminant migration. The equation conservatively disregards biodegradation, volatilization, and vadose transport phenomena.

The equation for the Summers analytical model is:

$$C_{gw} = \frac{(Q_p)(C_p) + (Q_a)(C_a)}{Q_a + Q_p}$$

Where:

C_{gw} = Projected contaminant concentration in the groundwater (mg/L)
Q_p = Volumetric flow rate of percolating rainwater into the aquifer (ft^3/day)
Q_p = $q_p \times A_p$, where:
  q_p = Vertical percolation in downward direction (ft/day)
  A_p = Horizontal area of contamination (ft^2)
C_p = Concentrations of pollutant in the infiltrating water at the unsaturated-saturated zone interface (mg/L)
C_p = C_s / K_d, where:
  K_d = Soil adsorption coefficient
  C_s = Soil exposure concentration (mg/kg)
Q_a = Volumetric flow rate of groundwater (ft^3/day), where:
  Q_a = $K \times i \times h \times w$, where:
    K = Saturated hydraulic conductivity (ft/day)
    h = Aquifer mixing zone thickness (ft)
    w = Width of contaminated area perpendicular to flow direction in aquifer (ft)
    i = Horizontal hydraulic gradient (ft/ft)
C_a = Initial or background concentration of the chemical in the aquifer (mg/L).

Assuming the background concentration of the contaminants in groundwater to be negligible, (i.e., C_a is assumed to be zero), the equations presented above were rearranged to solve for the groundwater concentration, as follows:

$$C_{gw} = \frac{C_s / K_d)(Q_p)}{Q_p + Q_a}$$

Assessment of the groundwater transport of site-related contamination toward potential receptor locations was conducted by evaluating a one-dimensional solute transport equation (van Genuchten and Alves 1982 after Ogata and Banks 1961) using site-specific aquifer properties. The one-dimensional convective-dispersive solute transport equation is:

$$c(x,t) = (c_o - c_i) * A(x,t)$$

Where:

$$A(x,t) = 0.5erfc[Rx - vt / 2*(DRt)^{1/2}] + 0.5\exp(vx / D)*erfc[Rx + vt / 2*(DRt)^{1/2}]$$

A(x,t) = Transport factor
R = Retardation coefficient
x = Distance from source (ft)
D = Dispersion coefficient
v = Groundwater velocity (ft/day)
t = Time
c_i = Pulse concentration
c_0 = Input concentration
erfc = Complementary error function
exp = Exponential function.

The analytical model assumes a continuous pulse source and does not incorporate source or chemical decay associated with biodegradation or volatilization.

5.4.4 Results of Transport Estimates

The rearranged Summers equation was evaluated over a range of K_d values between 0.1 and 10,000 mL/g with areas of contamination between 100 and 1×10^7 ft^2. These values encompass the range of values associated with the chemical constituents identified in the ALAAP soils and the estimates of the contaminated areas. The input soil concentration was 1 mg/kg so that all estimated groundwater concentrations were normalized to 1. The remaining input values (**Table 5-3**) for the model were constants representing the average aquifer conditions. The resulting matrix of calculated groundwater values is shown in **Table 5-4**. The calculated values represent multipliers over a variety of chemical partitioning conditions and areas of contamination that would be applied to soil concentrations to estimate the groundwater concentration. As shown in Table 5-4, conditions of low chemical partitioning (K_d=0.01 mL/g) and a large area of soil contamination (10,000,000 ft^2) produce the highest (9.95) groundwater concentration multiplier, while the combination of a large K_d (=10,000 mL/g) and a small area of contamination (100 ft^2) results in the lowest (2.09×10^{-7}) estimated groundwater concentration multiplier.

5.4.4.1 Groundwater Transport Estimates

Dissolved constituents will be transported by groundwater at a rate that is consistent with subsurface conditions. The ability of the aquifer to retard the movement of the solutes is described by the groundwater velocity and the K_d, which typically varies by orders of magnitude and is imprecisely known on a site-specific basis. Similarly, the chemical speciation (particularly for metals) also is typically unknown, resulting in further uncertainty in using literature values in attenuation calculations.

Table 5-3. Parameters Used in Summers Model Transport Calculations
Alabama Army Ammunition Plant, Childersburg, Alabama

Parameter	Symbol	Selected Value	Units	Reference
Volumetric rate of infiltration	Q_p	site specific	ft^3/day	Calculated by $Q_p=q_p*A_p$
Vertical percolation	q_p	0.0041	ft/day	q_p calculated by subtracting runoff (Rr) and evapotranspiration (ET) from site precipitation (P) q_p=P-ET-Rr
Horizontal area ofcontamination	A_p	site specific	ft^2	Area of individual study areas
Volumetric rate of groundwater flow	Q_s	site specific	ft^3/day	$Q_s=K_s*i*h*w$
Hydraulic conductivity of aquifer	K_s	49.9	ft/day	Calculated AAAP arithmetic average
Horizontal hydraulic gradient	i	0.005	ft/ft	Calculated AAAP average
Mixing zone thickness	h	10	ft	Default value
Width of contamination perpendicular to groundwater flow direction	w	site specific	ft	Measured width of each site assuming groundwater flow to northwest towards Coosa River
Soil/water distribution coefficient	K_d	chemical specific	L/mg	Values for metals from literature; K_d for organics calculated as $K_d=K_{oc}*foc$
Fraction organic carbon	f_{oc}	site specific	unitless	95% UCL calculated from analytical measurements at AAAP
Organic carbon partition coefficient	K_{oc}	chemical specific	L/kg	Literature values (see Table 5-1)

Table 5-4. Results of Soil to Groundwater Leaching Calculations
Alabama Army Ammunition Plant, Childersburg, Alabama

Chemical	Soil Concentration (C_s)- mg/kg						*K_d	Projected Groundwater Concentration (ug/L)					
	A	B	C	D	E	F	(mL/g)	A	B	C	D	E	F
Metals													
Aluminum		38300		17500			1500		9710		9610		
Arsenic				24.90			200				103		
Barium		231	118.00	231	68.20		50		1760	1870	3810	990	
Beryllium				2.60			800				3		
Cadmium						31.90	40						443
Copper	23.20	19.10		172			35	599	207		4050		
Chromium				66.10		76.40	30				1820		1410
Hexavalent Chromium						2.31	30						42.7
Lead	86.70	1800		373		3710	100	784	43		3070		20600
Manganese	1170	1300		1850	4100	1210	750	1410	659		2030	3970	895
Mercury	0.08	0.17		0.24		1.50	10	81	6		20		83.3
Molybdenum	3.44			10.10		9.40	125	3440			67		41.7
Nickel	13.20	16.20		11000			300	13	21		30200		
Selenium			12.20				500			19			
Vanadium				140				1000			115		
Zinc	66.30	212		316		4750	1300	66300	62		200		2030
Volatile Organic Compounds (VOCs)													
Acetone	4.00		0.76	1	0.05	0.07	0.0020	158000		177000	342000	17100	2490
2-Butanone	0.004						0.0733	55					
Chloroethane						0.00143	0.7830						1.01
Ethybenzene			0.015				8.40			1.4			
Methylene Chloride	0.0069	0.0054	0.0043	0.0094	0.0089	0.0076	0.0613	8.7	0.19	32	1.03	105	8.14
Toluene	0.0078	0.0240	0.0174	0.0084	0.0924	0.0062	1.69	0.36	0.31	4.7	0.336	40	2.42
Explosives													
1,3-Dinitrobenzene	0.05						1.24	36					
2,4-Dinitrotoluene	26100		1.43	1.33		0.51	0.608	5750000		1860	254		95.5
2,6-Dinitrotoluene	0.06						4.51	11					
1,3,5-Trinitrobenzene			0.39			0.161	0.09			3400			203
2,4,6-Trinitrotoluene			2.96	0.16		1.330	4.97			472	3.82		30.4
Tetryl				0.08			1.89				36		
2-Amino-4,6-Dinitrotoluene						0.0996	2.97						18.6
4-Amino-2,6-Dinitrotoluene						0.0976	2.97						18.2

Table 5-4. Results of Soil to Groundwater Leaching Calculations (Continued)
Alabama Army Ammunition Plant, Childersburg, Alabama

Chemical	Soil Concentration (C_s)- mg/kg						*K_d	Projected Groundwater Concentration (ug/L)					
	A	B	C	D	E	F	(mL/g)	A	B	C	D	E	F
Semivolatile Organic Compounds (SVOCs)													
2-Methylnapthalene				0.256		1.140	211				0.69		3.00
Acenaphthene				1.95		4.360	242				4.57		9.99
Acenapthylene				0.425			494				0.709		
Anthracene	0.099			6.380		7.430	821	7.88E-02			4.42		5.02
Benzo(a)anthracene	0.293	1.200	0.198	19.0		3.620	1140	1.62E-02	1.84E-02	0.06	0.91		0.17
Benzo(a)pyrene	0.289	1.300	0.236	14.0		4.720	5690	6.80E-03	8.49E-03	0.03	0.29		0.09
Benzo(b)fluoranthene	0.484	2.400	0.657	20.0		4240	22100	2.93E-03	4.03E-03	0.02	0.11		21.80
Benzo(g,h,i)perylene	0.161	0.930	0.169	10.0		194	101000	2.13E-04	3.41E-04	0.00	0.01		0.22
Benzo(k)fluoranthene		1.300	0.304	8.300		20.300	41200		1.17E-03	0.01	0.02		0.06
Bis(2-Ethylhexyl)phthalate	0.132			0.112			8050	1.48E-02			0.01		
Chrysene	0.221	1.300	0.320	19.00		12.600	2430	1.22E-02	1.99E-02	0.11	0.91		0.59
Dibenzo(a,h)anthracene				1.210		6.890	27200				0.03		0.14
Dibenzofuran				0.642		2.630	384				0.95		3.80
Fluoranthene	0.219	4.400	0.350	60		12.500	1270	2.30E-02	1.28E-01	0.22	5.48		1.11
Fluorene				1.52		3.830	731				1.18		2.91
Heptachlor	0.092						1010	8.22E-02					
Ideno(1,2,3-cd)pyrene	0.130	0.840	0.149	8.3		51.300	272000	6.39E-05	1.15E-04	0.0004	0.0035		0.02
N-Nitrosodiphenylamine				0.23		0.088	18				7.28		2.71
Naphthalene				0.487		2.690	68				4.06		21.90
Phenanthrene	0.155	1.200		30.0		61.200	838	1.21E-01	2.60E-01		20.30		40.50
Pyrene	0.635	2.100	0.669	30.9		26.500	902	9.42E-02	8.65E-02	0.59	3.98		3.34
Styrene				0.002			61				0.02		

* Minimum Kd values that were used in calculations.
A - Study Areas 2,3,17,18,20.
B-Study Area 4
C- Study Areas 6,7
D- Study Areas 8,9
E- Study Area 10
F- Study Areas 16,19,22

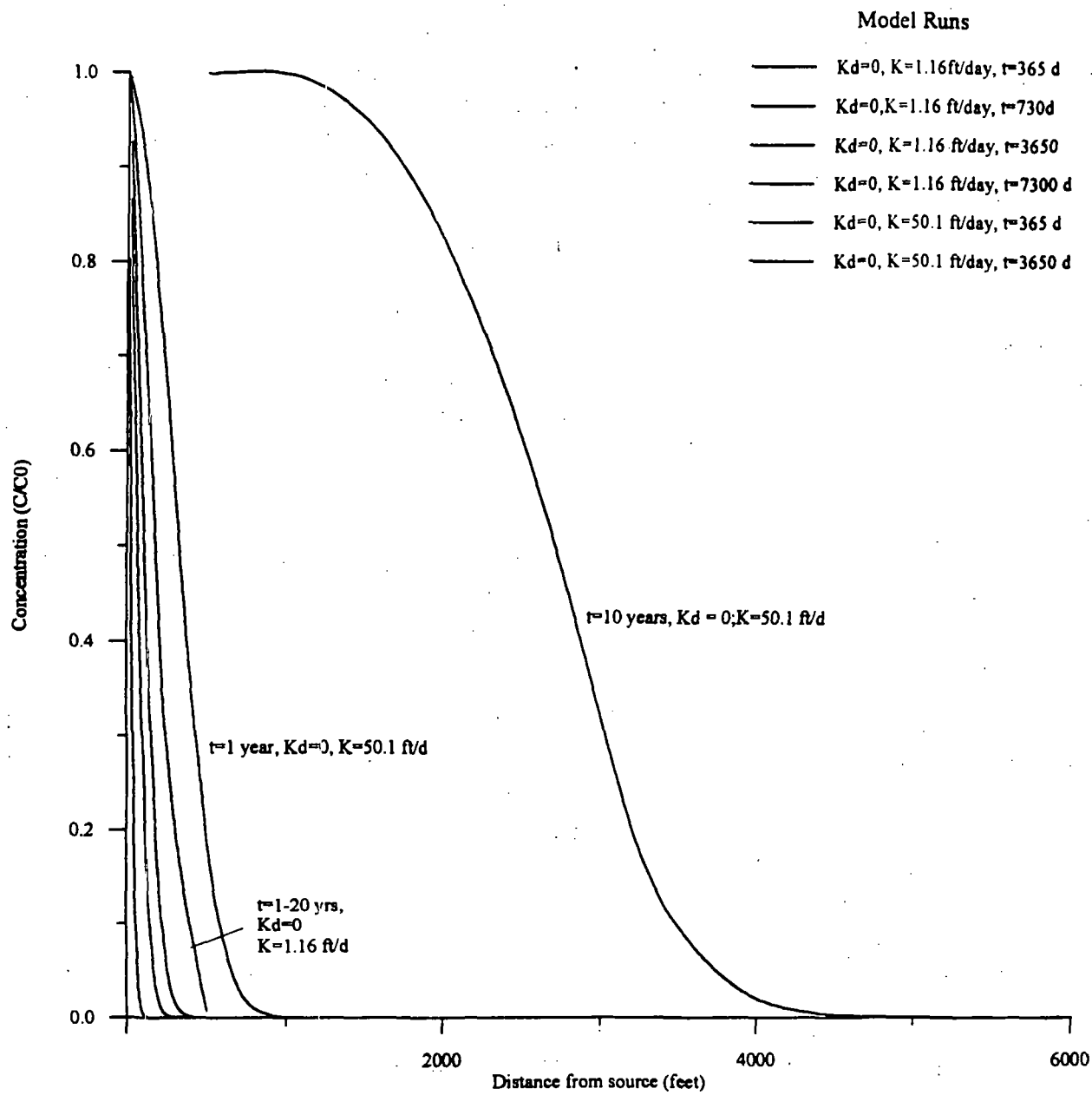
The results of solute transport calculations in the saturated zone indicate that the selected K_d value significantly impacts the downgradient concentration and the migration distance independent of the chemical constituent. Attenuated solute transport calculated with a K_d value between 5 and 100 mL/g indicates maximum chemical movement of 25 to 200 feet from a source location over a period of 20 years. This pattern of movement is contrary to the observed distribution of explosives and lead in groundwater at the site, indicating that the partition coefficients may be excessive for the site.

Unattenuated solute transport (K_d = 0 mL/g) calculations indicate that chemical transport up to 750 feet from a source location could occur over a 20-year period under average (geometric) groundwater flow (0.02 feet/day) conditions. This distance would be more consistent with the observed distribution of chemical constituents in the aquifer, which extends approximately 2,400 feet downgradient. The time period for development of the observed distribution of explosives and lead in the aquifer is likely to extend from the period following the cessation of production activities at ALAAP to the present and would account for the larger observed distribution area. The results of unattenuated solute transport calculations are shown in **Figure 5-4**.

The source of lead concentrations in groundwater at ALAAP is problematic in that elemental and mineralogic lead are typically insoluble in water, the speciation of potentially lead-bearing compounds is not known, the average groundwater pH is slightly acidic (6.8 units), and the average K_d value for lead is 100 mL/g (Dragun 1988). These conditions are not conducive to the dissolution and transport of lead in the absence of a highly soluble lead salt or hydroxide or the occurrence of more severe pH conditions. Groundwater transport of elevated concentrations of dissolved lead and explosives is significant because of the presence of pathways of enhanced flow and proximity to receptors. Equilibrium groundwater chemistry calculations using MINTEQA2 (EPA 1991f) indicate that soluble lead sulfate ($PbSO_4$), lead carbonate ($PbCO_3$), or lead bicarbonate ($PbHCO_3$) occur as equilibrium solids using cation groundwater concentrations from ALAAP wells and anion data for Talladega County (Moser 1988).

5.4.4.2 Surface Water and Sediment

Water budget calculations estimate that 28 percent of the annual average precipitation at ALAAP occurs as surface runoff from the site. Surface water runoff at ALAAP is not expected to be a significant chemical transport mechanism because of the abundant vegetative cover over most of the soils, the extensive remediation that has occurred in the surface water drainages, particularly the Red Water Ditch, and in the vicinity of surface water bodies (i.e., Study Areas 6 and 7). The suspension of fine-grained soil particles may occur during periods of elevated runoff or storm events, however, sampling at the site has not detected elevated concentrations of mission-related constituents in the soils and sediments that could potentially become entrained at the site. The surface water and sediment are not the primary source of contamination in the drainage ditches at ALAAP.



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Unattenuated Transport Results

Figure No.	Project No.	File Name	Date
5-4	01-0827-03-8178-045	99015\DWGS\E42F5-5	03-31-99

The analysis of site surface water and sediment data show that, in general, contaminant loading into drainage ditches from ALAAP is small to negligible. However, because low-lying portions of the drainage system at ALAAP intersect the water table, a greater possibility exists for the transport of contaminants into the drainage system through groundwater discharge with subsequent discharge into the Coosa River. Groundwater discharges to surface water, predominantly in the vicinity of the Beaver Pond drainage area and in swampy areas between Study Areas 6, 18, and 20, may potentially result in surface water conditions that locally contain unacceptably elevated concentrations of explosive compounds or metals.

5.4.5 Air

The air pathway is not an important chemical migration pathway from ALAAP because of the overgrown nature of the site and the lack of ongoing activity. However, contaminants could migrate from the site to the air during remedial activities that will disturb the ground surface. During periods of turbulent wind conditions, particles of surface materials (e.g., contaminated soil) can become resuspended in ambient air and subject to inhalation by onsite and/or offsite human receptors. The amount that may be resuspended depends on wind speed and other site conditions, such as soil moisture, particle size, and vegetative cover. Resuspended particles then are carried downwind to onsite and offsite receptors. Concentrations of these airborne contaminant-bearing particles at receptor locations form the basis for assessment of exposure by the inhalation pathways. However, at ALAAP, the majority of the area is vegetated; therefore, the potential for wind erosion is minimal under current conditions.

Because comparatively few VOCs have been detected in groundwater or soils at the site and the detected concentrations are relatively low, emission of VOCs from contaminated soils via diffusion through the pore space in the vadose zone is not regarded as an important transport mechanism at this site. Because the most widely detected chemical constituents are semivolatile polycyclic aromatic hydrocarbons (PAHs) compounds and explosives, the expectation for vapor emissions from the site soils is low.

5.5 SUMMARY AND CONCLUSIONS

Based on site characterization and monitoring data, inorganic (metals) and organic compounds, including explosives compounds, were observed in groundwater underlying ALAAP. The site-specific contribution of observed contaminant concentrations in soil to observed concentrations in groundwater is unknown, although the observed soil concentrations have a potential for leaching and migration to groundwater. Offsite migration of groundwater contaminants has not been observed, although several isolated contaminated groundwater locations are proximal to groundwater discharge points on the Coosa River.

Organic compounds that were detected in the site soils include VOCs, SVOCs, and explosives compounds. The concentrations of VOCs and SVOCs are low and should not leach to the groundwater in significant concentrations. Most of these compounds will biodegrade (such as

acetone, 2-butanone, and methylene chloride with biodegradation rates greater than 0.005 day^{-1}) or will remain adsorbed to the soil (such as the PAHs with K_d values greater than 100 mL/g). Based on leachate modeling, only TNT, 2,4-DNT, 1,3,5-TNB, and 1,3-DNB would be expected to leach to groundwater from existing soil contamination. Observed VOC and SVOC concentrations for frequently detected (detected in >5 percent of samples), nonlaboratory related compounds from sampled groundwater are less than 32 µg/L. A large percentage of the identified explosives concentrations in soil and sediment at the site have been remediated.

The source or sources of organic constituents and in particular, the explosives concentrations that are prevalent in groundwater at the site, is unresolved and may include multiple areas, including the vicinities of Study Areas 2, 17, and 18 or locations south of ALAAP in the former General Services Administration (GSA) area (now Alliance Coosa Pines Facility). Lead concentrations in groundwater at ALAAP are problematic in that elemental and mineralogic lead are typically insoluble in water, the speciation of potentially lead-bearing compounds at the site is not known, the average groundwater pH is slightly acidic (6.8 units), and the average K_d value for lead is 100 mL/g (Dragun 1988). These conditions are not conducive to the dissolution and transport of lead in the absence of a highly soluble lead salt or hydroxide or the occurrence of more severe pH conditions.

Surface runoff is currently not an important migration pathway because of vegetative covering for most of the area. The analysis of site surface water and sediment data show that, in general, contaminant loading into drainage ditches from ALAAP are small to negligible. Because the bottom of the drainage system at ALAAP intersects the water table, a greater possibility exists for the transport of contaminants into the drainage system with subsequent discharge into the Coosa River. Similarly, the air pathway is not an important pathway for contaminant migration from ALAAP owing to the overgrown nature of the site and the lack of ongoing activity. However, contaminants could migrate from the site to the air during remedial activities that will disturb the ground surface.

6. HUMAN HEALTH RISK ASSESSMENT

A baseline human health risk assessment was conducted to determine the potential for adverse effects associated with exposure to chemicals present at the study areas under investigation at Area B at the Alabama Army Ammunition Plant (ALAAP). Baseline risks are the risks to human health in the absence of remediation or institutional controls at the site.

The subjects of the human health risk assessment are study areas within Area B that are known or suspected to have treated, stored, or disposed hazardous waste. Soil, surface water, sediment, groundwater, and biota samples were collected to examine the nature, magnitude, and extent of contamination at these study areas. The associated data were used to determine the baseline risks to human health. The risk assessment provides information used in determining whether or not remedial action is necessary or justifiable.

The human health risk assessment was conducted in accordance with the process recommended by the U.S. Environmental Protection Agency (EPA) in *Risk Assessment Guidance for Superfund* (RAGS) (EPA 1989a) and EPA Region IV in *Supplemental Guidance to RAGS* (EPA 1995c). Following this guidance, the human health risk assessment has been organized into the following sections:

- Data Collection and Evaluation (Section 6.1)
- Exposure Assessment (Section 6.2)
- Toxicity Assessment (Section 6.3)
- Risk Characterization (Section 6.4)
- Uncertainty (Section 6.5).

Section 6.5 has been added to discuss the uncertainty associated with the human health risk assessment. As currently specified by EPA, risk assessments rely on conservative (i.e., health-protective) single-value point estimates. In this approach, point estimates are used as terms in intake equations that produce point risk estimates when solved. Single point estimates by themselves do not reflect the range of possible values that could reasonably be used. The resulting risk estimates appear to be more precise than they actually are, when in fact they often err to an uncertain degree on the side of health protection. The uncertainty assessment is intended to enhance the environmental decision-making process by providing additional information regarding the degree of conservatism of the risk estimates.

6.1 DATA COLLECTION AND EVALUATION

This section consists of a brief overview of the data used in the human health risk assessment and the process used to select chemicals of potential concern (COPCs). COPCs are defined as chemicals that are potentially site-related and are present at levels that may affect human health. COPCs are the chemicals that are evaluated quantitatively in the risk assessment and are

selected in accordance with guidance from EPA Headquarters and EPA Region 4 (EPA 1989a, 1995c). Also included in this section is a comparison of site data to chemical-specific applicable or relevant and appropriate requirements (ARARs).

6.1.1 Data Used in the Risk Assessment

The following environmental monitoring data have been incorporated into the risk assessment: all data collected by Science Applications International Corporation (SAIC) to support this Supplemental Remedial Investigation/Feasibility Study (RI/FS); background surface soil data collected by Environmental Science & Engineering, Inc. (ESE) in 1993 (ESE 1995); confirmatory data collected from Study Areas 2, 6, 7, 10, 16, 17, 19, and 21 by Roy F. Weston (Weston 1996a, e, and f), and Environmental Chemical Corporation (ECC) confirmatory data for lead at Study Areas 16 and 19 (ECC 1998). The Roy F. Weston and ECC data were collected following excavation of contaminated areas to verify that the remaining soils and sediments are not contaminated. Field screening data were not used in the quantitative risk assessment.

A fourth phase of investigation is under way and focuses specifically on groundwater contamination within Area B. A separate report will be prepared that will integrate the Phase 4 groundwater results with those from Phases 1 through 3.

SAIC data have been analyzed and validated in accordance with U.S. Army Environmental Center (USAEC) protocols (USAEC 1995a and USATHAMA 1990). During the validation process, data were qualified based on the results of the quality assurance/quality control (QA/QC) samples (e.g., laboratory and field blanks). The validation methods and results are described in Appendix I. Data collected by ESE, although not validated in accordance with USAEC protocols, were validated against EPA SW846 Method Criteria (Methods 6010 and 8330).

After the validation process was complete, the following SAIC data were used in the human health and ecological risk assessments:

- Data with detected analytes that have no Installation Restoration Data Management Information System (IRDMIS) data qualifiers or flagging codes
- Data with detected analytes that have IRDMIS data qualifiers or flagging codes other than A, B, G, I, U, and R
- If an analyte was detected at least once in a data set, "not detected" results for that analyte were treated as one-half the limit of detection
- Sample results with IRDMIS flags A, B, G, I, and U were treated as not detected and included in the risk assessment as one-half the reported value; these flags are explained in greater detail in the Data Quality Assessment (Section 4.2 and Appendix I).

The following were excluded from the human health and ecological risk assessments:

- Data in which analytes were rejected during data validation (no data were rejected for the Supplemental RI)
- Field duplicates—field duplicates are QA/QC samples that were collected to assess variability in the sampling process; therefore, they are discussed in the Data Quality Assessment (Section 4.2 and Appendix I), but the analytical results were not included in the calculation of the exposure point concentrations
- In accordance with EPA Region IV guidance (EPA 1995c), filtered groundwater data were excluded from the human health risk assessment because these data may underestimate chemical concentrations in water from an unfiltered tap.

6.1.2 COPC Selection

The first step of the COPC selection process was to organize or aggregate the available data for evaluation in the risk assessment and to support the calculation of the exposure point concentrations (i.e., the concentrations of chemical constituents at the point of contact with the receptor). Next, a background comparison was performed to determine which inorganic chemicals are considered site-related and which are products of naturally occurring background conditions. Those chemicals considered site-related were identified as chemicals exceeding background (CEBs). Finally, CEBs were subjected to two screens: the essential nutrient screen and the risk-based concentration (RBC) screen. Chemicals emerging from this process were designated as COPCs and summary statistics were calculated for the COPCs. A flow chart illustrating the COPC selection process is presented in **Figure 6-1**. The following paragraphs discuss these steps.

6.1.2.1 Data Aggregation

Data aggregation refers to the manner in which sample data are grouped for analysis and evaluation in the RI. For risk assessment to be meaningful, the evaluation must focus on key receptors at potential risk of exposure within the land use area and circumstances under which exposure is most likely to occur. The concept of the "exposure unit" is therefore introduced as the basis for assessment of exposure. The exposure unit may be thought of as a geographical area within which receptors would realistically be expected to experience average exposure to contaminants spatially and temporally. The exposure unit is defined on the basis of observed or assumed patterns of receptor behavior and the nature and extent of contamination. Data were first aggregated within each study area by medium (e.g., soil, surface water, and groundwater) and then horizontally and vertically into discrete exposure units.

Soil—For risk assessment of soil, each study area was designated as a single exposure unit (with the exception of the Community Environmental Response Facilitation Act [CERFA] study

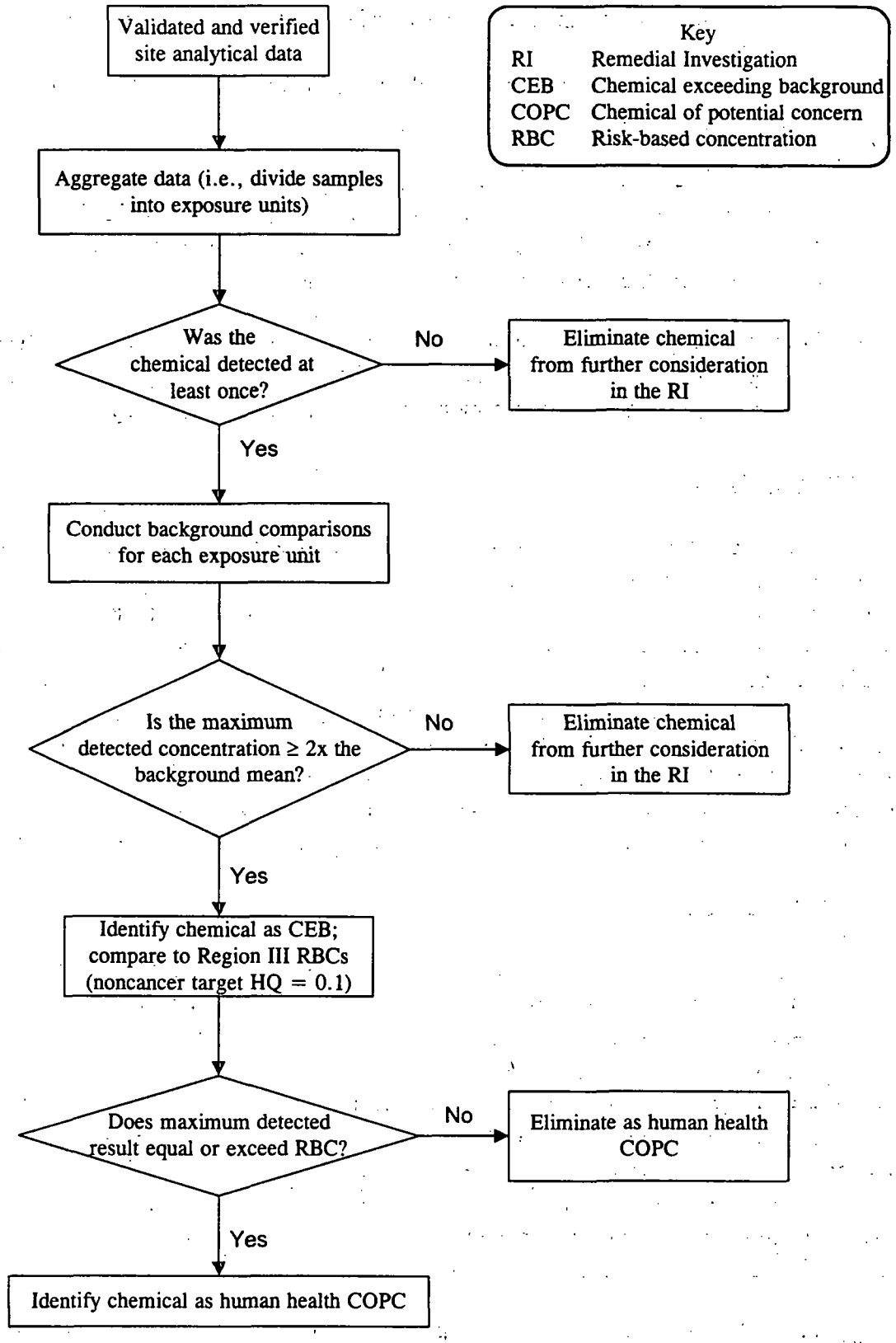


Figure 6-1. COPC Selection Process

areas). Data were aggregated in this manner due to historical activities (activities generally varied between areas but not within a given study area), types of contaminants (in many instances, the type of contaminant varied from one study area to another), and exposure considerations (the study areas are large enough that individuals could spend all of their time in only one study area).

The CERFA study areas were kept as separate exposure units even though some are located within or adjacent to non-CERFA study areas. Different contaminants are associated with the CERFA study areas (e.g., polychlorinated biphenyls [PCBs] at the Transformer Storage Building and Utility Poles), and the sampling plan reflects a spatial bias that is not present at the non-CERFA study areas.

Soil data were divided into surface and shallow subsurface data sets. Surface soils include data collected from 0 to 1 foot below land surface (BLS). Subsurface soils are composed of data collected from 1 to 10 feet BLS. Subsurface soils below 10 feet BLS were not considered in the risk assessment because soil deeper than 10 feet BLS is generally below the typical construction zone for the region and because of the high water table in the area.

Surface water and sediment—For risk assessment of surface water and sediment, the exposure units are as follows:

- Background—Fanning Creek, Little Blue Creek, and Talladega Creek (upstream of Area B)
- Red Water Ditch (Study Area 21)
- Crossover Ditch (Study Area 26, including swampy areas generally located between Study Areas 6, 18, and 20)
- Beaver Ponds and streams leading to and from the Beaver Ponds (Study Area 27)
- Talladega Creek (includes tributaries from Study Areas 16, 19, and 22).

Despite their large size, study areas such as the Crossover Ditch and the Red Water Ditch were not broken into multiple exposure units because the initial screening data and confirmatory sampling data demonstrated that concentrations of target chemicals (e.g., explosives) were generally consistent and relatively low across the exposure unit.

According to Region IV guidance, it is generally "...unnecessary to evaluate human exposures to sediments covered by surface water" (EPA 1995c). Because the Coosa River and Talladega Creek are both perennial water bodies, human exposures to these sediments were not evaluated in the human health risk assessment.

Groundwater—Risk assessment of groundwater was conducted for four exposure units corresponding to wells associated with Study Areas 16 and 19; wells associated with the Main Industrial Area (i.e., all Area B wells except those associated with Study Areas 16 and 19); wells associated with the Blending/Shipping Area (Study Areas 17, 18, and 20); and wells associated with the Smokeless Powder Facility (Study Area 2). The first two exposure units were chosen because geologic and hydrogeologic investigations have inferred a divide approximately in the vicinity of the southern portion of Study Area 17, which isolates Study Areas 16 and 19 from the remainder of Area B (see discussion in Section 4.4). The Blending/Shipping Area and the Smokeless Powder Area were designated as exposure units because they represent the two areas with the most significant explosive contamination. These exposure units were created to address EPA Region IV policy of using wells in the highly concentrated area of the plume to calculate exposure point concentrations. Wells included in these exposure units were selected using 2,4-dinitrotoluene (2,4-DNT) as the indicator explosive.

Groundwater data were not aggregated based on depth. Hydrogeologic investigations indicate that the soil residuum and the bedrock are hydraulically connected (Section 4.4).

A fourth phase of investigation is under way and focuses specifically on groundwater contamination within Area B. A separate report will be prepared that will integrate the Phase 4 results with those from Phases 1 through 3. This additional report will therefore present a more thorough evaluation of groundwater contamination at Area B.

6.1.2.2 Background Comparison

In accordance with EPA Region IV guidance (EPA 1995c), SAIC conducted a background comparison to determine if observed concentrations of inorganic analytes reflect naturally occurring conditions or site-related environmental impact. A background comparison was not conducted for organic compounds because background concentrations of organic compounds are assumed to be zero at the exposure units under investigation. Therefore, all detected organic compounds were considered site-related.

For soils, the background comparison was conducted separately for each horizon. For surface soils, background data collected from 0 to 1 foot BLS were compared to study area data from the same depth. For shallow subsurface soils, study area and background data were compared for the 1 to 10 feet BLS interval. Data collected at depths greater than 10 feet BLS were not used in the risk assessment.

The background criterion for a given analyte is a value equal to two times the mean background concentration. If the maximum detected value in an exposure unit equaled or exceeded the background criterion, the analyte was considered site-related and identified as a CEB. Analytes with maximum detected concentrations below the background criterion were eliminated as CEBs and from the risk assessment. CEBs (i.e., site-related chemicals) were then subjected to further screening to determine the list of COPCs.

The background comparison is discussed in Section 4.3. The results of the background comparison are presented in the Appendix N tables, structured like Table 2 from RAGS Part D (EPA 1998a).

6.1.2.3 Essential Nutrient Screen

Chemicals considered essential nutrients were subjected to a screen. These chemicals are essential to proper functioning of the human body, are generally present at low concentrations, and are toxic only at very high doses. At Area B, calcium, magnesium, potassium, and sodium were considered essential nutrients.

Because EPA-verified toxicity values are not available for these essential nutrients, an approach involving the U.S. Food and Drug Administration (FDA) dietary values (DVs) (formerly known as recommended daily allowances [RDAs]) (FDA 1997) was used. This approach consisted of using the DV and exposure factors to estimate levels in soil and groundwater that may be considered analogous to or consistent with dietary limits. The maximum detected concentration for each nutrient in each medium from each solid waste management unit (SWMU) was then compared to these calculated concentrations. If the maximum detected concentration was less than the dietary value, the metal was eliminated as a COPC. Appendix M shows the conversion of the FDA dietary value to concentrations in soil and groundwater.

6.1.2.4 RBC Screen

As recommended by EPA Region IV (EPA 1995c), the EPA Region III RBCs (EPA 1998b) were used in selecting COPCs for soil, sediment, groundwater, and fish tissue. The RBCs are chemical concentrations corresponding to fixed levels of hazard or risk (a hazard quotient [HQ] of 0.1 or lifetime cancer risk of 1×10^{-6}, whichever occurs at a lower concentration). An HQ of 0.1 was used (rather than 1) to account for the effects of additivity. The RBCs are essentially risk assessments run in reverse for a single contaminant, in a single medium, assuming standard default exposure assumptions.

For a given CEB, the RBC screen was conducted by comparing the maximum detected concentration in the exposure unit to the RBC. If the maximum detected value was less than the RBC, the CEB was eliminated as a COPC and excluded from the risk assessment. If the maximum detected value was equal to or greater than the RBC, or if an RBC was not available, the CEB was considered a COPC (assuming it was not eliminated in the essential nutrient screen). The residential soil RBCs were used in the selection of soil and sediment COPCs.

Surface water concentrations were screened against the Ambient Water Quality Criteria (AWQC) (human health for consumption of water and organisms). As with the Region III RBCs, the maximum detected concentration in the exposure unit was compared to the AWQC. If the maximum detected value was less than the criterion, the analyte was eliminated as a COPC and

excluded from the risk assessment. If the maximum detected value was equal to or greater than the criterion, or if an AWQC was not available, the analyte was considered a COPC.

6.1.2.5 Rationale for COPC Selection and Calculation of Summary Statistics

The Appendix N tables, structured like Table 2 in RAGS Part D (EPA 1998a), present the results of the background comparison, nutrient screen, and RBC screen, and show the COPCs for each SWMU along with the rationale for their selection. These tables include the following information:

- Minimum and maximum detected concentrations
- Qualifiers for the minimum and maximum detected concentrations
- Location of maximum concentration
- Frequency of detection
- Range of contract required quantitation limits (CRQLs) and contract required detection limits (CRDLs)
- Concentration used for screening
- Background value
- Screening toxicity value
- Potential ARARs, To Be Considered (TBC) guidance, and associated sources.

If a chemical was not detected in a given exposure unit, it was eliminated as a COPC and from further consideration in the risk assessment. If a chemical was detected at least once but not in every sample collected within the exposure unit, the "not detected" results were treated as one-half the limit of detection and included in the risk calculations. Field duplicates were not included in the data set used to calculate risk.

At Area B, most of the wells were sampled more than once to evaluate concentration variability over time. Data collected from the same well were first averaged and then included in the risk assessment. In addition, at a few soil and sediment locations, samples were collected more than once to support the ecological risk assessment. As with the groundwater, the sampling results from a single location were averaged before being included in the risk assessment.

For each exposure unit, the remaining COPCs were inspected. If none remained, the exposure unit was removed from further consideration in the human health risk assessment. In

Appendix N, tables formatted using the same structure specified for Table 3 in RAGS Part D (EPA 1998a) present the following:

- Arithmetic mean concentration
- 95 percent upper confidence limit (UCL_{95}) on the mean
- Maximum detected concentration
- Qualifiers for the maximum detected concentration
- Exposure point concentrations used under both the reasonable maximum exposure (RME) and central tendency exposure (CTE) scenarios.

6.1.3 ARARs Comparison

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) specifies that remedial actions for the cleanup of hazardous substances must comply with the standards under Federal or more stringent State environmental laws. These laws are ARARs and apply to the hazardous substances or particular circumstances at a site. ARARs may be chemical-, location-, or action-specific.

During the risk characterization, levels of risk associated with each receptor are estimated and chemicals of concern (COCs) are identified if risks exceed regulatory targets. COCs are carried into the FS and are the chemicals on which the remediation effort is focused. In accordance with EPA Region IV guidance (EPA 1995c), chemicals exceeding ARARs are designated as COCs, along with chemicals that exceed EPA targets as determined in the human health and ecological risk assessments.

For the identification of COCs based on exceedance of ARARs, the comparison has been limited to chemical-specific ARARs that are promulgated under Federal or State law. At Area B, groundwater concentrations from each sample collected were compared to State and Federal maximum contaminant levels (MCLs) (EPA 1995e). Chemical-specific ARARs promulgated under Federal or State law are not available for other media being evaluated at ALAAP, Area B. The results of this comparison are shown in **Table 6-1**.

In accordance with the framework for conducting FSs, each remedial alternative considered must evaluate compliance with ARARs. Therefore, a complete discussion of all pertinent ARARs is presented in the FS for Area B.

Table 6-1. ARARs Comparison with State and Federal MCLs for Groundwater Alabama Army Ammunition Plant, Childersburg, Alabama

	Exceedances of Federal and Alabama State MCLs				
	Sample ID			Sample	MCL[a]
Chemical	Site ID	Site Type	Field Sample	Conc. (ug/L)	(ug/L)
Arsenic	D7B	WELL	SAIC01	200	50
Beryllium	GW-04-003	WELL	SAIC01	5.6	4
	P-5	WELL	SAIC01	6.8	
Lead	D7B	WELL	SAIC01	94	15
	GW-02-001	WELL	SAIC01	23	
	GW-02-002	WELL	SAIC01	35	
	GW-03-003	WELL	SAIC01	134	
	GW-04-001	WELL	SAIC02	1,600	
	GW-04-001	WELL	SAIC04	88	
	GW-04-003	WELL	SAIC01	35	
	GW-10-001	WELL	SAIC01	1,200	
	GW-16-005	WELL	SAIC01	69	
	GW-16-006	WELL	SAIC01	240	
	GW-16-007	WELL	SAIC01	28	
	GW-17-002	WELL	SAIC01	37	
	GW-17-002	WELL	SAIC02	450	
	GW-17-004	WELL	SAIC01	138	
	GW-17-006	WELL	SAIC01	310	
	GW-17-006	WELL	SAIC02	660	
	GW-17-006	WELL	SAIC03	185	
	GW-18-001	WELL	SAIC01	300	
	GW-18-002	WELL	SAIC01	360	
	GW-18-003	WELL	SAIC01	65,000	
	GW-18-003	WELL	SAIC02	55	
	GW-18-003	WELL	SAIC04	47	
	GW-20-01BR	WELL	SAIC01	26	
	P-5	WELL	SAIC01	60	
	P-10	WELL	SAIC01	97	
	P-10	WELL	SAIC02	100	
	P-35	WELL	SAIC01	19	
	P-69	WELL	SAIC03	25	
Carbon Tetrachloride	P-60	WELL	SAIC01	6.4	5
	P-60	WELL	SAIC02	6.1	
Pentachlorophenol	D-14	WELL	SAIC01	2.1	1
	D4	WELL	SAIC01	1.4	
	P-10	WELL	SAIC01	1.9	
	P-14	WELL	SAIC01	1.6	
	P-44	WELL	SAIC01	9.0	
	P-44	WELL	SAIC02	11	
	P-64	WELL	SAIC01	1.8	
	P-68	WELL	SAIC01	2.4	
Vinyl Chloride	D7B	WELL	SAIC01	3.5	2
bis(2-Ethylhexyl)phthalate	D-16	WELL	SAIC02	70	6
	D-7B	WELL	SAIC01	15	
	GW-02-001	WELL	SAIC01	51	
	P-35	WELL	SAIC01X	10	
	P-67	WELL	SAIC02	9.1	

a - Lesser of the ADEM or Federal Maximum Contaminant Level (MCL) for drinking water supplies.

6.2 EXPOSURE ASSESSMENT

The objective of the exposure assessment is to estimate the type and magnitude of potential human exposures to COPCs. For a given receptor group, this results in an estimate of chronic daily intake or dose of COPCs from environmental media at ALAAP. The exposure assessment, in conjunction with the subsequent toxicity assessment (discussed in Section 6.3), supports the characterization of potential risks to human health (discussed in Section 6.4). The exposure assessment consists of the following principal components:

- Characterization of current and future land uses and identification of potentially exposed receptors
- Identification of potential exposure pathways
- Derivation of exposure point concentrations
- Development of chemical intake or dose estimates.

EPA guidance (EPA 1989a and 1992e) specifies that an RME scenario should be developed. The RME is a conservative exposure case that is in the high end of the range of possible exposures. In addition, a CTE scenario also is evaluated and used to contrast average exposures with the RME estimates. The CTE estimate differs from the RME estimate in that the exposure assumptions (e.g., exposure frequency, exposure duration, and ingestion rate) are generally mid-range rather than high-end values.

EPA requires that RME results be the primary focus of the risk assessment. Therefore, the risk assessment conclusions and recommendations are based on the RME estimates. CTE estimates are presented in Appendix N, along with the RME estimates, and are discussed in the uncertainty section of the risk assessment. The inclusion of both central tendency and high-end estimates provides more information regarding the possible distribution of risks, and enhances the decision-making process regarding the potential need for remediation.

6.2.1 Land Use Assumptions and Potentially Exposed Receptors

The following section describes land uses at the study areas under investigation and the receptor populations that may potentially be exposed to contaminants. The risk assessment evaluates both current and future land use scenarios.

6.2.1.1 Current and Future Industrial Land Use

Currently, Area B is inactive. It was under caretaker status until recently (January 2001). Access is controlled through the use of fences, gates, and locks. Areas adjacent to Area B include Kimberly-Clark Corporation (an industrial facility that manufactures paper products) and Area A,

which is a privately owned game preserve. According to the Site Management Plan prepared by USAEC for ALAAP (USAEC 1995b), "...remedial investigation/action efforts, property transfer, sales or leases will be restricted to an industrial reuse scenario." Under a future industrial scenario, new buildings would likely be constructed on the study areas under investigation. In the risk assessment, an industrial scenario has been evaluated that is inclusive of both the caretaker scenario that existed at the beginning of this investigation and a future industrial scenario. The current and future industrial worker is assumed to be exposed to surface soil.

6.2.1.2 Future Recreational Land Use

The future recreational scenario is included to account for use of the land for recreational purposes (e.g., a park or open area, a hunting area), or trespassing (should the property be retained by the U.S. Army or sold to a private party). In the risk assessment, the recreational receptors are exposed to surface soil, and to surface water and sediment while wading. Ingestion of fish and rabbit also was evaluated under the future recreational land use scenario. Exposure to subsurface soil was not evaluated because soil intrusive activities (i.e., activities involving exposure to soil below 1 foot BLS) are not expected.

6.2.1.3 Future Construction Scenario

The future construction scenario assumes that buildings (e.g., residences or commercial buildings) are constructed or roads are built on the study areas under investigation. The construction worker is different from the industrial worker in that some of the exposure assumptions are different (e.g., soil ingestion rate and exposure duration) and the construction worker is assumed to be exposed to subsurface soil in addition to surface soil (see Sections 6.2.3 and 6.2.4.2 for discussions on the exposure point concentrations and exposure assumptions used in the risk assessment, respectively). Exposure to subsurface soil could occur during construction activities (e.g., excavation).

6.2.1.4 Future Residential Land Use

In accordance with EPA Region IV guidance (EPA 1995c), a residential scenario has been included at all study areas because residential development cannot be ruled out entirely. However, residential conversion is unlikely because the Army has chosen the industrial scenario as the selected future reuse (USAEC 1995b). In the risk assessment, residential receptors are exposed to surface and subsurface (up to 10 feet BLS) soils, groundwater, surface water, and sediment. Ingestion of fish and rabbit also was evaluated under the future residential land use scenario. Residents were evaluated for exposure to subsurface soil because of the possibility of soil redistribution. During excavation and regrading (such as conducted during construction of buildings and residences), soils that were 1 to 10 feet BLS may be redistributed at the surface.

6.2.1.5 Potentially Exposed Receptors

Under the current and future industrial and the future construction worker scenarios, the receptor at potential risk is a worker, who is an adult. Therefore, children are not evaluated under these scenarios.

Under the residential and recreational land use scenarios, adults and children are at potential risk of exposure. The residential child is defined as a 15 kilogram child between the ages of 1 and 6 years. The recreational child is defined as a 45 kilogram child between the ages of 7 and 16 years. Future recreational land use may include hunting. Therefore, the adult recreational receptor also may be a hunter.

It is not appropriate to calculate cancer risks for a child separate from an adult because carcinogenic effects accumulate over the lifetime of the individual. Rather, a combined cancer risk that encompasses both childhood and adulthood must be evaluated for the receptor. For noncancer effects, hazards are appropriately calculated for a child separately from the adult. For clarification of this concept, the risk assessment refers to the receptor exposed to carcinogens as an "integrated child/adult" and the receptors exposed to noncarcinogens as a "child" or an "adult."

6.2.2 Identification of Potential Exposure Pathways

Exposure pathways describe "the course a chemical or physical agent takes from the source to the exposed individual" (EPA 1989a). An exposure pathway comprises the following four components:

- A source and mechanism of chemical release
- A retention or transport medium (or media)
- A point of potential human contact with the contaminated medium (the exposure point)
- An exposure route (e.g., ingestion, dermal contact, and inhalation).

Each of these elements must be present for the pathway to be complete and considered further in the risk assessment. Some complete pathways may not be quantified if the contribution to hazard or risk is clearly minor relative to other major pathways.

Figure 6-2 presents the exposure pathways from source to receptor as a conceptual site model (CSM). The CSM is a simple diagram used to help define complete exposure pathways, understand the nature and extent as well as the fate and transport of contamination, and develop preliminary remedial alternatives. As shown in the CSM, the human health risk assessment evaluated soil, groundwater, surface water, sediment, and food chain pathways.

In a complete exposure pathway, exposure occurs at the point at which contact is made between receptors and contaminants. The exposure point may represent only a small portion of the

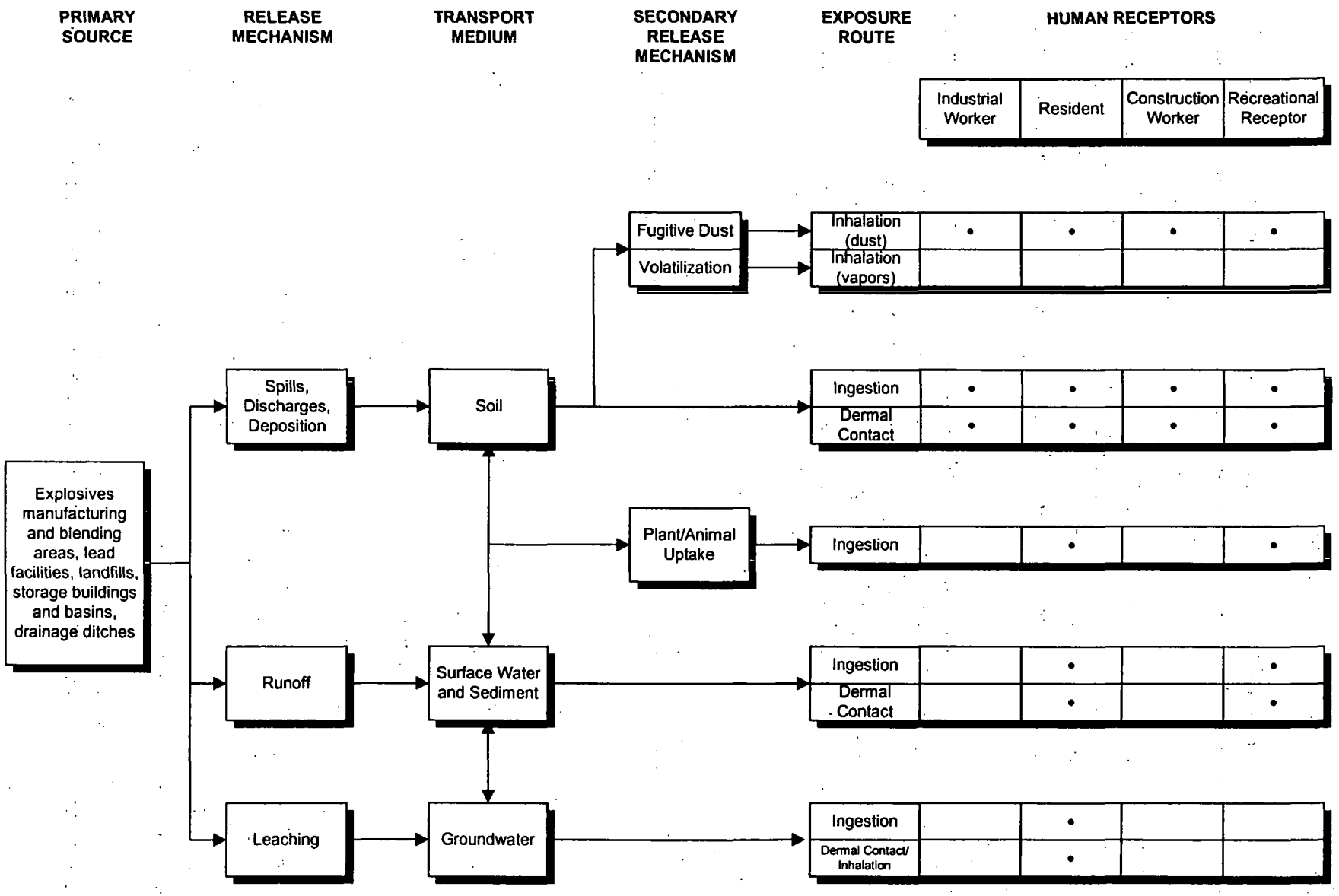


Figure 6.2. Conceptual Site Model for Human Health Risk Assessment

entire exposure pathway. If there is no exposure point, there is no exposure, even if contaminants have been released into the environment (e.g., contaminants that are migrating in soils that are too deep to excavate).

If a complete exposure pathway is indicated, the exposure assessment estimates the average contaminant concentration and potential for human uptake at the exposure point. Hazard and risk estimates are then calculated for exposures occurring to environmental media at the exposure point via the relevant exposure routes (e.g., ingestion, dermal contact, and inhalation). **Tables 6-2** and **6-3** present the exposure pathways evaluated in the human health risk assessment.

6.2.2.1 Soil Pathways

Soil ingestion, dermal contact with soil, and inhalation of suspended soil particulates were evaluated for each receptor.

6.2.2.2 Groundwater Pathways

Groundwater pathways were evaluated only for the future residential land use scenario. Groundwater exposures are not evaluated under current land use because water is supplied to Area B by the nearby county water treatment plant (which obtains its water from the Coosa River). Future developers of Area B would most likely continue to use the water supplied by the county water treatment plant. No drinking water wells are located within Area B.

Under future residential land use, groundwater pathways were evaluated in the unlikely event that a resident installed a well. Exposures to groundwater in the home include ingestion and exposure to volatile organic compounds (VOCs) while showering. Region IV risk assessment guidance (EPA 1995c) indicates that intake of VOCs while showering is equivalent to the intake from ingesting 2 liters of water per day. This approach is used for adults and children. The method includes exposures via the inhalation and dermal routes.

Groundwater migration to surface water and subsequent effects on sediment are of possible concern in the Beaver Ponds and in swampy areas generally located between Study Areas 6, 18, and 20. However, surface water and sediment monitoring data collected in the Beaver Ponds (Study Area 27) and in the swampy areas were used to estimate risks to human receptors (Section 6.4.4), thereby accounting for possible groundwater discharge to these areas. Samples collected in the swampy areas are included in the Study Area 26 exposure unit.

6.2.2.3 Surface Water and Sediment Pathways

Surface water and sediment pathways have been evaluated in the risk assessment for future residents and recreational receptors while wading. Wading is considered more realistic than swimming because the majority of the water bodies (e.g., Red Water Ditch, Crossover Ditch, and

Table 6-2. Exposure Pathways for the Human Health Risk Assessment Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area/ Exposure Unit	Land Use	Receptor	Soil			Surface Water[a]		Sediment[a]		Fish/Game[b]
			Ingestion	Dermal Contact	Particulate Inhalation	Ingestion	Dermal Contact	Ingestion	Dermal Contact	Ingestion
2 - Smokeless Powder Facility	Current/Future	Industrial Worker	•	•	•					
	Future	Construction Worker	•	•	•					
	Future	Recreational Receptor	•	•	•					
	Future	Resident	•	•	•					
3 - Sanitary Landfill and Lead Facility	Current/Future	Industrial Worker	•	•	•					
	Future	Construction Worker	•	•	•					
	Future	Recreational Receptor	•	•	•					
	Future	Resident	•	•	•					
4 - Manhattan Project Area	Current/Future	Industrial Worker	•	•	•					
	Future	Construction Worker	•	•	•					
	Future	Recreational Receptor	•	•	•					
	Future	Resident	•	•	•					
5 - Red Water Storage Basin	Current/Future	Industrial Worker								
	Future	Construction Worker								
	Future	Recreational Receptor						•	•	
	Future	Resident						•	•	
6 - Southern TNT Manufacturing Area	Current/Future	Industrial Worker	•	•	•					
	Future	Construction Worker	•	•	•					
	Future	Recreational Receptor	•	•	•					
	Future	Resident	•	•	•					
7 - Northern TNT Manufacturing Area	Current/Future	Industrial Worker	•	•	•					
	Future	Construction Worker	•	•	•					
	Future	Recreational Receptor	•	•	•					
	Future	Resident	•	•	•					
8 - Acid/Organic Manufacturing Area	Current/Future	Industrial Worker	•	•	•					
	Future	Construction Worker	•	•	•					
	Future	Recreational Receptor	•	•	•					•
	Future	Resident	•	•	•					•
8 - Testpits	Current/Future	Industrial Worker								
	Future	Construction Worker	•	•	•					
	Future	Recreational Receptor								
	Future	Resident	•	•	•					
9 - Aniline Sludge Basin, Tar, Sediments Beneath Tar	Current/Future	Industrial Worker								
	Future	Construction Worker								
	Future	Recreational Receptor				•	•	•	•	
	Future	Resident				•	•	•	•	
10 - Tetryl Manufacturing Area - East	Current/Future	Industrial Worker	•	•	•					
	Future	Construction Worker	•	•	•					
	Future	Recreational Receptor	•	•	•					•
	Future	Resident	•	•	•					•
10 - Tetryl Manufacturing Area - West	Current/Future	Industrial Worker	•	•	•					
	Future	Construction Worker	•	•	•					
	Future	Recreational Receptor	•	•	•					
	Future	Resident	•	•	•					
16 - Flashing Ground	Current/Future	Industrial Worker	•	•	•					
	Future	Construction Worker	•	•	•					
	Future	Recreational Receptor	•	•	•	•	•	•	•	•
	Future	Resident	•	•	•	•	•	•	•	•
17 - Propellant Shipping Area	Current/Future	Industrial Worker	•	•	•					
	Future	Construction Worker	•	•	•					
	Future	Recreational Receptor	•	•	•					•
	Future	Resident	•	•	•					•
18 - Blending Tower Area	Current/Future	Industrial Worker	•	•	•					
	Future	Construction Worker	•	•	•					
	Future	Recreational Receptor	•	•	•					
	Future	Resident	•	•	•					
19 - Lead Facility	Current/Future	Industrial Worker	•	•	•					
	Future	Construction Worker	•	•	•					
	Future	Recreational Receptor	•	•	•					
	Future	Resident	•	•	•					

Table 6-2. Exposure Pathways for the Human Health Risk Assessment (Continued) Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area/ Exposure Unit	Land Use	Receptor	Soil			Surface Water[a]		Sediment[a]		Fish/Game[b]
			Ingestion	Dermal Contact	Particulate Inhalation	Ingestion	Dermal Contact	Ingestion	Dermal Contact	Ingestion
20 - Rifle Powder Finishing Area	Current/Future	Industrial Worker	•	•	•					
	Future	Construction Worker	•	•	•					
	Future	Recreational Receptor	•	•	•					
	Future	Resident	•	•	•					
21 - Red Water Ditch	Current/Future	Industrial Worker								
	Future	Construction Worker								
	Future	Recreational Receptor				•	•	•	•	•
	Future	Resident				•	•	•	•	•
22 - Demolition Landfill	Current/Future	Industrial Worker	•	•	•					
	Future	Construction Worker	•	•	•					
	Future	Recreational Receptor	•	•	•					
	Future	Resident	•	•	•					
25 - Storage Battery/Demolition Debris	Current/Future	Industrial Worker	•	•	•					
	Future	Construction Worker	•	•	•					
	Future	Recreational Receptor	•	•	•					
	Future	Resident	•	•	•					
26 - Crossover Ditch	Current/Future	Industrial Worker								
	Future	Construction Worker								
	Future	Recreational Receptor				•	•	•	•	•
	Future	Resident				•	•	•	•	•
27 - Beaver Pond Drainage System	Current/Future	Industrial Worker								
	Future	Construction Worker								
	Future	Recreational Receptor				•	•	•	•	•
	Future	Resident				•	•	•	•	•
Building 6 - Coke Oven	Current/Future	Industrial Worker	•	•	•					
	Future	Construction Worker	•	•	•					
	Future	Recreational Receptor	•	•	•					
	Future	Resident	•	•	•					
Transformer Storage Building and Utility Poles	Current/Future	Industrial Worker	•	•	•					
	Future	Construction Worker	•	•	•					
	Future	Recreational Receptor	•	•	•					
	Future	Resident	•	•	•					
Underground Storage Tanks	Current/Future	Industrial Worker								
	Future	Construction Worker	•	•	•					
	Future	Recreational Receptor								
	Future	Resident	•	•	•					
Gas Station	Current/Future	Industrial Worker								
	Future	Construction Worker	•	•	•					
	Future	Recreational Receptor								
	Future	Resident	•	•	•					
Fertilizer and Pesticide Storage	Current/Future	Industrial Worker	•	•	•					
	Future	Construction Worker	•	•	•					
	Future	Recreational Receptor	•	•	•					
	Future	Resident	•	•	•					
Talladega Creek	Current/Future	Industrial Worker								
	Future	Construction Worker								
	Future	Recreational Receptor				•	•	•	•	•
	Future	Resident				•	•	•	•	•
Coosa River	Current/Future	Industrial Worker								
	Future	Construction Worker								
	Future	Recreational Receptor				•	•	•	•	•
	Future	Resident				•	•	•	•	•

Blank spaces represent incomplete pathways.
[a]Surface water and sediment exposures were evaluated under a wading scenario.
[b]Ingestion of rabbit is evaluated at Study Areas 8, 10, 16, 17, and in background. Ingestion of fish is evaluated at Study Areas 21, 26, 27, Talladega Creek, and in background. Ingestion of crayfish is not evaluated in the human health risk assessment.

Table 6-3. Exposure Pathways for the Human Health Risk Assessment - Groundwater Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area/ Exposure Unit	Land Use	Receptor	Groundwater[a]	
			Ingestion	Dermal and Inhalation
Main Industrial Area (all of Area B except Study Areas 16 and 19)	Current/Future	Industrial Worker		
	Future	Construction Worker		
	Future	Recreational Receptor		
	Future	Resident	•	•
Study Areas 16 and 19	Current/Future	Industrial Worker		
	Future	Construction Worker		
	Future	Recreational Receptor		
	Future	Resident	•	•
Smokeless Powder Area	Current/Future	Industrial Worker		
	Future	Construction Worker		
	Future	Recreational Receptor		
	Future	Resident	•	•
Blending/Shipping Area	Current/Future	Industrial Worker		
	Future	Construction Worker		
	Future	Recreational Receptor		
	Future	Resident	•	•
Background	Current/Future	Industrial Worker		
	Future	Construction Worker		
	Future	Recreational Receptor		
	Future	Resident	•	•

[a]Based on the recommendation of the Risk Assessment Forum and EPA Region IV guidance, the risk assessment has assumed that the intake of VOCs from showering is equivalent to the intake of VOCs from ingestion of 2 liters of water per day (EPA Region IV guidance, EPA 1995c).

Beaver Pond Drainage System) on or passing through Area B are relatively shallow (fewer than 4 feet) and may dry up during the late summer months. The upper portions of the Red Water Ditch and Crossover Ditch are dry from 3 to 6 months of the year. The Beaver Ponds are perennial, but shrink during the dry months. Workers are assumed to have minimal or no contact with surface water and sediment. The pathways evaluated are surface water ingestion and dermal contact, and sediment ingestion and dermal contact.

In accordance with EPA Region IV guidance (EPA 1995c), human exposures to sediments that are continuously covered by surface water need not be evaluated. Therefore, human exposures to sediments in Talladega Creek and the Coosa River are not addressed because both are perennial water bodies.

6.2.2.4 Food Chain Pathways

Monitoring data are available for crayfish, fish, and rabbit at Area B. Under the residential and recreational land use scenarios, ingestion of fish and rabbit was evaluated in the risk assessment. Rabbits were chosen because they represent an edible game species readily available at the site and have a relatively small home range (a few acres). Ingestion of crayfish was excluded from the human health risk assessment because it is unlikely that crayfish would constitute a significant part of a receptor's diet given their small size and scarcity at Area B. Larger crayfish, which are not local, are available in grocery stores at fairly inexpensive prices.

At Study Areas 26 and 27, monitoring data are available for fish fillets (with the skin removed). The fillet is the muscular sides of the fish associated with the ribs and excludes the head, tail, backbone, and viscera. Because human receptors eat only the fillet, these data have been used to calculate risk for human health (rather than data for the whole fish).

6.2.3 Derivation of Exposure Point Concentrations

Exposure point concentrations are the concentrations of chemicals in a given medium to which human receptors are exposed at the point of contact. Exposure point concentrations are used to calculate the chemical intakes or doses for human receptors based on methodology provided in EPA's Supplemental Guidance to RAGS: Calculating the Concentration Term (EPA 1992g). The calculation of intakes or doses for the human receptors is discussed in Section 6.2.4.

Because of the uncertainty associated with any estimate of exposure concentration, EPA has selected a conservative approach in which the UCL_{95} of the mean or the maximum detected concentration (whichever is lower) is used as the exposure point concentration. This concentration is called the RME concentration. The UCL_{95} represents the upper 95 percent confidence limit of the arithmetic mean, meaning there is a 95 percent probability that the average exposure point concentration will fall at or below the UCL_{95}. Given a large, normally distributed data set, the UCL_{95} is expected to be only slightly larger than the mean. If, however, the data set is small, variable, and is not normally distributed, the UCL_{95} may be much larger than the mean, and may

even exceed the maximum detected value. Because the UCL_{95} is sensitive to the data distribution and the number of samples, the smaller of the UCL_{95} or maximum detected value was chosen as the RME concentration (EPA 1992g).

Methods used to derive the UCL_{95} are dependent on the underlying shape of the distribution of the data set. Consequently, the data were first tested to determine if they were normally or lognormally distributed using probability plot correlation coefficients (EPA 1992c). If the data were found to be normally distributed, the exposure point concentration was calculated as the UCL_{95} on the arithmetic mean of the data using the student's t-statistic. If the data were found to be lognormally distributed or if a distribution could not be defined, the exposure point concentration was calculated as the UCL_{95} of the arithmetic mean using the H-statistic (EPA 1992a). The H-statistic is used to compute a one-sided 95 percent UCL on a lognormal mean (Gilbert 1987).

As discussed in Section 6.1, "not detected" results were treated as one-half the limit of detection (assuming that the analyte was detected at least once in a given data set) and included in the calculations of the UCL values. Field duplicates are discussed in the data quality assessment (Appendix I), but the analytical results are not included in the calculation of the exposure point concentrations.

For groundwater, EPA Region IV guidance recommends the use of wells within the highly concentrated area of the plume to calculate exposure point concentrations. For this reason, two exposure units were established, the Blending/Shipping Area and the Smokeless Powder Area, that include wells in the highly concentrated areas of explosive contamination (Section 6.1.2.1). Exposure point concentrations for these two exposure units are the arithmetic mean of the sample results. In addition, groundwater data were aggregated in another manner due to hydrogeologic considerations: wells associated with Study Areas 16 and 19, and wells associated with the Main Industrial Area (i.e., all Area B wells except those associated with Study Areas 16 and 19). Exposure point concentrations calculated for these exposure units are the lesser of the 95 percent UCL and the maximum detected value.

Groundwater data collected from the same well over time were first averaged and then included in the risk assessment. Where additional soil or sediment samples were collected from a single location, sample results were averaged before being included in the risk assessment.

Surface soil data from 0 to 1 foot BLS (but not including 1 foot BLS) were used to calculate exposure point concentrations for the current and future industrial and future recreational land use scenarios. For future construction worker and resident exposures, both surface and subsurface soils (0 to 10 feet BLS) were used in the risk assessment.

In Appendix N, tables structured like Table 3 in RAGS Part D present the exposure point concentrations used in the human health risk assessment.

6.2.4 Development of Chemical Intakes

This section provides information concerning the equations and exposure factors (i.e., assumptions) used to calculate chemical intakes or dose estimates. The risk assessment used intake equations that were developed and applied in accordance with methods presented by EPA in RAGS (EPA 1989a).

The oral and inhalation intake estimates are expressed as the administered dose of a chemical (i.e., the amount of chemical at an exchange boundary, such as the skin or the intestinal wall, that is available for absorption). However, dermal doses are estimates of absorbed dose (the amount of chemical actually absorbed into the bloodstream). All chemicals are assumed not to transform or degrade over the period of exposure (i.e., the concentration in the medium of concern remains the same).

6.2.4.1 Exposure Equations

Intake estimates (in mg/kg-day) were developed for each COPC using the corresponding exposure point concentration. Chemical intakes (or absorbed dose for dermal contact pathways) are estimated by means of the following general equation:

$$\text{Intake (mg/kg-day)} = \frac{C \times IR \times EF \times ED \times CF}{BW \times AT}$$

Where:

C	=	Chemical concentration (exposure point concentration)
IR	=	Intake rate
EF	=	Exposure frequency
ED	=	Exposure duration
CF	=	Conversion factor (to attain units of mg/kg-day)
BW	=	Body weight
AT	=	Averaging time for noncancer or cancer effects.

Pathway-specific intake equations are presented in Appendix M, Section M.1, and in the Appendix N tables that are structured like Table 4 in RAGS, Part D.

6.2.4.2 Exposure Factors

Two sets of exposure factors or assumptions were developed, one representing CTE estimates and the other representing RME estimates. The CTE factors estimate average or mean exposures and may be compared with the high-end RME estimates. Following EPA Region IV

direction, the CTE estimates are discussed in the uncertainty section and are not used in decisionmaking regarding the need for remediation.

The exposure factors are combined with the exposure point concentrations to calculate intake or dose. The exposure factors and corresponding guidance or rationale used in this risk assessment are presented in **Tables 6-4** and **6-5**. In most cases, published exposure assumptions were used (EPA 1991a, 1991b, 1992a, 1993a, and 1996a).

6.3 TOXICITY ASSESSMENT

The objectives of the toxicity assessment are to evaluate the inherent toxicity of the compounds under investigation and to identify and select toxicity values for use in risk characterization. For the assessment of human health risks from exposure to chemicals, the following toxicity values are of principal importance:

- Reference doses (RfDs) for oral exposure—acceptable intake values for chronic exposure (noncancer effects)
- Reference concentrations (RfCs) for inhalation exposure—acceptable intake values for chronic exposure (noncancer effects); these have been converted to inhalation RfDs by multiplying by 20 cubic meters per day and dividing by 70 kg
- Cancer slope factors (CSFs) for oral exposure
- CSFs for the inhalation route.

Toxicity information is preferably obtained from the Integrated Risk Information System (IRIS) (EPA 1999). If values are not available from IRIS, the Health Effects Assessment Summary Tables (HEAST) (EPA 1997b) are consulted.

EPA recommends two different approaches for evaluating noncancer and cancer health effects. The two approaches reflect a fundamental difference in the proposed mechanism of toxic action. In assessing the potential for noncancer health effects, EPA assumes that there is a toxicologic threshold below which no adverse health effects occur. These toxicologic thresholds are represented by RfDs for oral exposures and RfCs for inhalation exposures. The RfDs and RfCs are levels (with uncertainty spanning an order of magnitude or greater) of daily human exposures below which adverse health effects are not anticipated, even for the most sensitive members of a population (EPA 1989a). EPA derives RfDs and RfCs based on estimates of the no-observable-adverse-effect level (NOAEL) or lowest-observable-adverse-effect level (LOAEL) in humans or test animals. In this risk assessment, an RfC (concentration) is converted to an inhalation RfD (dose).

Table 6-4. Exposure Assumptions for Current and Future Industrial Land Use Alabama Army Ammunition Plant, Childersburg, Alabama

PATHWAY	ASSUMPTION	UNITS	CURRENT AND FUTURE LAND USE			
			Worker			
			RME		CTE	
General						
	Body weight	kg	70	a	70	c
	Exposure duration	years	25	a	5	c
	Averaging time - noncancer	days	9125	a	1825	c
	Averaging time - cancer	days	25550	a	25550	c
Soil Ingestion						
	Ingestion rate	mg/day	50	a	50	c
	Bioavailability factor	none	1	g	1	g
	Exposure frequency	days/year	250	a	219	c
	Conversion factor	kg/mg	1.00E-06	-	1.00E-06	-
Soil Dermal Contact						
	Skin surface area available	cm^2/day	5800	b	5000	b
	Soil to skin adherence factor	mg/cm^2	1	b	0.2	b
	Dermal absorption factor	none	chemical-specific			d
	Exposure frequency	days/year	250	a	219	c
	Conversion factor	kg/mg	1.00E-06	-	1.00E-06	-
Fugitive Dust Inhalation						
	Inhalation rate	m^3/day	20	a	20	e
	Respirable particulate concentration (< =10μm	mg/m^3	0.027	f	0.027	f
	Exposure frequency	days/year	250	a	219	c
	Conversion factor	kg/mg	1.00E-06	-	1.00E-06	-

a - EPA 1991a, Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors
b - EPA 1992a, Dermal Exposure Assessment; for skin surface area available during soil dermal contact, assumes 25 percent of to body surface area is exposed (pp. 8-10 and 8-12 of EPA 1992a)
c - EPA 1993a, Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure
d - A default value of 1.0 percent for organic compounds and 0.1 percent for inorganic chemicals was used (EPA Region IV guida
e - If guidance is not available for the CTE but exists for the RME, the RME value was conservatively adopted as the CTE
f - Average 24-hour average PM_{10} concentration from Childersburg, Alabama air sampling station for the period 1/90

Table 6-5. Exposure Assumptions for Residential, Recreational, and Construction Future Land Uses
Alabama Army Ammunition Plant, Childersburg, Alabama

PATHWAY ASSUMPTION	UNITS	FUTURE LAND USE																			
		Resident Children				Resident Adults				Recreational Children				Recreational Adults				Construction Workers			
		RME		CTE		RME		CTE		RME		CTE		RME		CTE		RME		CTE	
General																					
Body weight	kg	15	c	15	f	70	c	70	f	45	a	45	a	70	c	70	f	70	c	70	f
Exposure duration	years	6	c	2	f	24	c	7	f	10	a	10	a	24	c	7	f	2	h	1	i
Averaging time - noncancer	days	2190	c	730	f	8760	c	2555	f	3650	c	3650	c	8760	c	2555	f	730	c	365	f
Averaging time - cancer	days	25550	c	25550	f	25550	c	25550	f	25550	c	25550	c	25550	c	25550	f	25550	c	25550	f
Soil Ingestion																					
Ingestion rate	mg/day	200	c	100	f	100	c	50	f	100	b	50	b	100	c	50	f	480	c	240	i
Bioavailability factor	none	1	a	1	a	1	a	1	a	1	a	1	a	1	a	1	a	1	a	1	a
Exposure frequency	days/year	350	c	234	f	350	c	234	f	50	k	25	i	50	k	25	i	250	c	219	f
Conversion factor	kg/mg	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-
Soil Dermal Contact																					
Skin surface area available	cm^2/day	2010	e	1750	e	5800	e	5000	e	4100	e	3320	e	5800	e	5000	e	5800	e	5000	e
Soil to skin adherence factor	mg/cm^2	1	e	0.2	e	1	e	0.2	e	1	e	0.2	e	1	e	0.2	e	1	e	0.2	e
Dermal absorption factor	none	chemical-specific			g	chemical-specific			g	chemical-specific			g	chemical-specific			g	chemical-specific			g
Exposure frequency	days/year	350	c	234	f	350	c	234	f	50	k	25	i	50	k	25	i	250	c	219	f
Conversion factor	kg/mg	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-
Fugitive Dust Inhalation																					
Inhalation rate	m^3/day	15	a	15	j	20	c	20	f	13	b	13	j	9	b	9	j	24	b	20	c
Respirable particulate concentration	mg/m^3	0.027	m	0.027	m	0.027	m	0.027	m	0.027	m	0.027	m	0.027	m	0.027	m	0.027	m	0.027	m
Exposure frequency	days/year	350	c	234	f	350	c	234	f	50	k	25	i	50	k	25	i	250	c	219	f
Conversion factor	kg/mg	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-
Groundwater Ingestion																					
Ingestion rate	L/day	1	a	1	j	2	c	1.4	f	not evaluated								not evaluated			
Exposure frequency	days/year	350	c	234	f	350	c	234	f												
Conversion factor	mg/μg	1.00E-03	-	1.00E-03	-	1.00E-03	-	1.00E-03	-												
Groundwater Dermal Contact and Inhalation		Pathway evaluated in accordance with EPA Region IV guidance								not evaluated								not evaluated			
Sediment Ingestion (while wading)																					
Ingestion rate	mg/day	200	n	100	n	100	n	50	n	100	n	50	n	100	n	50	n	not evaluated			
Bioavailability factor	none	1	a	1	a	1	a	1	a	1	a	1	a	1	a	1	a				
Exposure frequency	days/year	45	a	23	i	45	a	23	i	25	k	13	i	25	k	13	i				
Conversion factor	kg/mg	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-				
Sediment Dermal Contact (while wading)																					
Skin surface area available	cm^2/day	2010	e	1750	e	5800	e	5000	e	4100	e	3320	e	5800	e	5000	e	not evaluated			
Sediment to skin adherence factor	mg/cm^2	1	n	0.2	n	1	n	0.2	n	1	n	0.2	n	1	n	0.2	n				
Dermal absorption factor	none	chemical-specific			n	chemical-specific			n	chemical-specific			n	chemical-specific			n				
Exposure frequency	days/year	45	a	23	i	45	a	23	i	25	k	13	i	25	k	13	i				
Conversion factor	kg/mg	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-				

Table 6-5. Exposure Assumptions for Residential, Recreational, and Construction Future Land Uses (Continued)
Alabama Army Ammunition Plant, Childersburg, Alabama

PATHWAY ASSUMPTION	UNITS	FUTURE LAND USE																			
		Resident Children				Resident Adults				Recreational Children				Recreational Adults				Construction Workers	
		RME		CTE		RME		CTE		RME		CTE		RME		CTE		RME	CTE
Surface Water Ingestion (while wading)																			
Ingestion rate	ml/hour	50	a	50	j	10	a	10	j	50	a	50	j	10	a	10	j	not evaluated	
Exposure time	hour/day	1	e	0.5	e	1	e	0.5	e	1	e	0.5	e	1	e	0.5	e		
Exposure frequency	days/year	45	a	23	i	45	a	23	i	25	k	13	i	25	k	13	i		
Conversion factor	mg/μg and L/ml	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-		
Surface Water Dermal Contact (while wading)																			
Skin surface area available	cm^2	2010	e	1750	e	5800	e	5000	e	4100	e	3320	e	5800	e	5000	e	not evaluated	
Permeability coefficient	cm/hour	chemical-specific			l	chemical-specific			l	chemical-specific			l	chemical-specific			l		
Exposure time	hour/day	1	e	0.5	e	1	e	0.5	e	1	e	0.5	e	1	e	0.5	e		
Exposure frequency	days/year	45	a	23	i	45	a	23	i	25	k	13	i	25	k	13	i		
Conversion factor	mg/μg and L/cm^3	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-	1.00E-06	-		
Rabbit Ingestion																			
Ingestion rate	kg/day	0.050	p	0.050	p	0.100	p	0.100	p	0.100	p	0.100	p	0.100	p	0.100	p	not evaluated	
Fraction ingested	none	1.0	o	1.0	o	1.0	o	1.0	o	1.0	o	1.0	o	1.0	o	1.0	o		
Exposure frequency	days/year	20	q	10	q	20	q	10	q	10	q	5	q	10	q	5	q		
Fish Ingestion																			
Ingestion rate	kg/day	0.03	p	0.03	p	0.03	p	0.03	p	0.03	p	0.03	p	0.03	p	0.03	p	not evaluated	
Fraction ingested	none	1	o	1	i	1	o	1	i	1	o	1	i	1	o	1	i		
Exposure frequency	days/year	120	r	120	r	120	r	120	r	120	r	120	r	120	r	120	r		

a - EPA 1995c, EPA Region IV guidance
b - EPA 1989b, Exposure Factors Handbook (EFH); the inhalation rate for construction workers was based on the reasonable worst-case outdoor inhalation rate of 3 m^3/hour and assuming an 8-hour work day; the inhalation rate for trespassers corresponds to approximately 4 hours of moderate activity per day
c - EPA 1991a, Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors
d - EPA 1991b, default values from Human Health Evaluation Manual, Part B
e - EPA 1992a, Dermal Exposure Assessment; for skin surface area available during soil, sediment, and surface water dermal contact, assumes 25 percent of total body surface area is exposed (pp. 8-10 and 8-12 of EPA 1992a)
f - EPA 1993a, Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure; the RME soil ingestion rate for the construction worker is for contact intensive activities
g - A default value of 1.0 percent for organic compounds and 0.1 percent for inorganic chemicals was used
h - The RME exposure duration for construction workers assumes 2 years of construction at an exposure unit
i - The CTE value has been estimated as one-half of the RME value
j - If guidance is not available for the CTE but does exist for the RME, the RME value was adopted as the CTE
k - For the recreational receptor, the RME frequency of exposure to soil corresponds to approximately 2 days per week for 6 months and the RME frequency of exposure to sediment and surface water under a wading scenario corresponds to approximately 1 day per week for 6 months
l - Dermal permeability constants used in this risk assessment are presented in Appendix J, Chemical-Specific Values Used in Evaluation of Dermal Exposure Pathways
m - Average 24-hour average PM_{10} concentration detected at the Childersburg, Alabama air sampling station for the period 1/90 through 6/91 (ESE 1995a)
n - For sediment exposures, due to limited available information, the ingestion rate, adherence factor, and dermal absorption factor are the same as for soil exposures
o - Assumes that all rabbit and fish ingested is from the study area under investigation
p - The fish ingestion rate was taken from the Alabama Department of Environmental Management (ADEM); the adult and recreational child rabbit ingestion rate is the average ingestion rate for beef consumption in Exposure Factors Handbook (EPA 1989b); the residential child ingestion rate is one-half the adult ingestion rate
q - Professional judgment
r - Assumes that fish is eaten on one-third of the days in the year

For carcinogens, however, EPA believes that assumption of a threshold is inappropriate (EPA 1989a). An extremely low level of exposure to a carcinogen may result in chromosomal or enzyme changes leading to cancer. Therefore, EPA does not estimate a threshold for carcinogens. Instead, EPA uses a two-part evaluation in which a chemical is assigned a weight-of-evidence classification and a CSF is calculated for the chemical. In risk assessment, the CSF is used to estimate the probability of a cancer effect occurring in an exposed receptor over a lifetime.

The weight-of-evidence classification evaluates the evidence that a given chemical is a carcinogen to humans and animals. These ratings are as follows:

- ***A***—Human carcinogen
- ***B1***—Probable human carcinogen; limited human data are available
- ***B2***—Probable human carcinogen; sufficient data in animals, and inadequate or no evidence in humans
- ***C***—Possible human carcinogen
- ***D***—Not classifiable as to human carcinogenicity.

EPA develops CSFs for carcinogens that have been classified as A, B1, and B2 and for many that have been classified as C. The CSFs are in units of inverse dose: $(mg/kg/day)^{-1}$.

Many of the toxic effects reported in the literature occur at much higher exposure levels than are likely for the substances that have been released into the environment at ALAAP Area B. This is an artifact resulting from the necessity of applying high doses to laboratory animals to elicit observable effects in a short period of time. Similarly, studies evaluating relatively high exposures to humans in occupational settings may have been used to develop some toxicity values that will be applied to residential exposures. In other cases, the route of exposure to a chemical influences the effects that are exhibited by a substance. The exposure route used in the experimental study (e.g., gastric gavage using a corn oil vehicle) may not relate to the exposure route being considered in the risk assessment.

The toxicity assessment process is complicated by the fact that toxicity values are not readily available for all exposure routes or all chemicals. However, EPA has provided guidance for: the dermal contact route, lead, polycyclic aromatic hydrocarbons (PAHs), use of provisional toxicity values, and chromium.

6.3.1 Dermal Contact Route

EPA toxicity values are available only for the oral and inhalation routes. In addition, most of these toxicity values are based on administered rather than absorbed dose. (The administered

dose is the amount of chemical at an exchange boundary, such as skin, that is *available* for absorption; the absorbed dose is the amount of chemical actually absorbed into the bloodstream.) The intake equations for dermal contact exposures calculate absorbed dose (by incorporating a dermal absorption factor or a permeability coefficient). Thus, it is necessary to convert the administered-dose toxicity value to an absorbed-dose toxicity value to calculate risk.

In accordance with RAGS (EPA 1989a), absorbed-dose toxicity values were derived from the oral administered-dose toxicity values to estimate risk associated with the dermal contact route. Adjustment of the oral administered dose toxicity values from absorbed-dose toxicity values requires sufficient data from the principal laboratory studies on oral absorption efficiency (i.e., gastrointestinal absorption factors) in the species on which the toxicity values are based.

Using these data, the administered-dose toxicity value was multiplied (if it is an RfD) or divided (if it is a CSF) by the gastrointestinal absorption factor to derive a toxicity value based on the absorbed dose. In cases where chemical-specific absorption factors are not available, EPA Region IV provides default absorption factors of 80 percent for VOCs, 50 percent for semivolatile organic compounds (SVOCs), and 20 percent for inorganic substances (EPA 1995c). The gastrointestinal absorption factors used in this risk assessment, including the toxicity values used to evaluate the dermal pathway are included in Appendix N. Dermal permeability coefficients and dermal absorption factors are included in Appendix M.

6.3.2 Lead

EPA does not provide a verified RfD or CSF for lead. The evaluation of lead was conducted by first comparing the maximum detected concentration at each exposure unit to the soil screening level of 400 mg/kg (EPA 1994a and 1994b) and to the action level in drinking water of 15 µg/L (EPA 1995e). If the maximum detected concentrations were less than or equal to these levels or if lead was eliminated in the background comparison, no further evaluation was conducted in accordance with EPA Region IV guidance (EPA 1995c). If maximum concentrations were greater than these levels, exposures were evaluated in two ways. For children, exposures to lead were analyzed by estimating blood lead levels using EPA's Integrated Exposure Uptake Biokinetic (IEUBK) computer model, LEAD 0.99d (EPA 1994c). Because the EPA model is applicable only to children, a model developed by EPA's Technical Review Workgroup for Lead (1996b) was used to estimate blood lead levels in adult workers. The model is not applicable to adults in a residential setting. Section 6.4.2 discusses the methodology and application of these models.

6.3.3 Polycyclic Aromatic Hydrocarbons

Most PAH compounds do not have published RfDs for noncancer effects, and only benzo(a)pyrene has a published slope factor for cancer effects. Therefore, EPA has provided interim guidance for evaluating some carcinogenic PAHs (EPA 1995c and 1993b). EPA recommends using toxicity equivalence factors (TEFs) to convert each carcinogenic PAH concentration to an equivalent concentration of benzo(a)pyrene. The concentration is adjusted

recognizing that there are no slope factors for any of the carcinogenic PAHs other than benzo(a)pyrene. TEFs are provided for seven PAHs (**Table 6-6**) and have been incorporated into the risk assessment. These values are related to the toxicity of benzo(a)pyrene and are based on reliable studies in which PAHs caused cancer after repeated exposures to mouse skin.

Table 6-6. TEFs for Carcinogenic PAHs
Alabama Army Ammunition Plant, Childersburg, Alabama

Compound	TEF
Benzo(a)pyrene	1.0
Benzo(a)anthracene	0.1
Benzo(b)fluoranthene	0.1
Benzo(k)fluoranthene	0.01
Chrysene	0.001
Dibenzo(a,h)anthracene	1.0
Indeno(1,2,3-cd)pyrene	0.1

Source: EPA Region IV guidance (EPA 1995c)

In accordance with EPA Region IV guidance (EPA 1995c), dermal contact and inhalation of carcinogenic PAHs were evaluated using the oral slope factor listed in IRIS and an inhalation slope factor (3.1 mg/kg-day)$^{-1}$, respectively. The same procedures used for oral exposures to carcinogenic PAHs (i.e., converting carcinogenic PAH concentrations to benzo(a)pyrene equivalent concentrations) also were applied to the dermal and inhalation exposures. The inhalation slope factor is a provisional toxicity value that is based on an inhalation study on hamsters. For PAHs exhibiting noncancer effects without EPA-approved RfDs, the RfD for pyrene was used as a surrogate.

The concentration adjustment is shown in Appendix N on the tables formatted using the same structure specified for Table 8 in RAGS Part D (EPA 1998a). The "Medium EPC Value" is the benzo(a)pyrene equivalent concentration.

6.3.4 Provisional Toxicity Values

Provisional toxicity values are available for some chemicals that have no current EPA-verified RfD or CSF. These values are issued by EPA's Superfund Health Risk Technical Support Center-National Center for Environmental Assessment of EPA (SHRTSC-NCEA). Provisional toxicity values were used in the baseline risk assessment (BRA) for ALAAP Area B.

Risk managers should recognize that cases in which provisional toxicity values are used should not generally be regarded with the same level of review as for EPA-verified toxicity values. For example, using provisional toxicity values may cause trichloroethylene to be identified as a chemical with human health effects exceeding EPA targets. The decision to remediate should be tempered with the understanding that the toxicity value is provisional, and may represent a low level

of review relative to EPA-verified toxicity values. Appendix N presents the toxicological data used in the risk assessment in tables structured like Tables 5 and 6 in RAGS Part D.

6.3.5 Chromium

At Area B, samples were analyzed for the presence of hexavalent chromium in each medium. Of approximately 85 samples collected, only 3 samples (2 soil and 1 groundwater) showed detectable levels of hexavalent chromium. The two detections in soil were 2.3 parts per million (ppm) in Study Area 22 and 1.7 ppm in Study Area 19. In each case, the ratio of hexavalent to trivalent chromium was less than 6 percent. In groundwater, hexavalent chromium was detected at 20 parts per billion (ppb) in one well that is upgradient of Study Area 2. Hexavalent chromium was not detected in the other wells in which it was analyzed.

As a conservative measure, even if hexavalent chromium was not detected in any of the samples, the risk assessment assumed that 10 percent of the chromium was in the hexavalent form. Therefore, the risk assessment for hexavalent chromium was conducted as follows:

- If both hexavalent and total chromium were detected as a given exposure unit, the monitoring data were used to calculate separate risks for hexavalent and trivalent chromium (using the total chromium concentration to calculate risks for the trivalent form, which is conservative).
- If monitoring data were available only for total chromium at a given exposure unit, the risk assessment assumed a 9:1 ratio of trivalent to hexavalent chromium. The ratio was used to adjust the total chromium concentration yielding separate hexavalent and trivalent chromium exposure point concentrations. Risk assessment was then conducted on the two separate concentrations.

The issue of valence is important for chromium because hexavalent chromium is a carcinogen by inhalation (whereas the trivalent form is not) and has a more stringent (i.e., lower) RfD than trivalent chromium (chromium III).

Based on the known history of past practices at the study areas under investigation, there were no processes at the study areas in which hexavalent chromium was produced. In soil, trivalent chromium and its complexes generally are very stable, whereas hexavalent chromium is highly unstable. Hexavalent chromium is readily reduced to trivalent chromium in the presence of organic matter and by residual amounts of iron in weathering minerals (Eary and Rai 1989). This information supports the use of the 9:1 ratio of trivalent to hexavalent chromium where speciation was not conducted.

6.4 RISK CHARACTERIZATION

Risk characterization combines exposure estimates with toxicity values to calculate HQs, cancer risks, or blood lead levels for all exposed human receptors defined in the human health risk assessment. The objective of the human health risk characterization is to determine whether exposure to chemicals at the study area poses risks that exceed target levels for human health effects. The results of the human health baseline risk assessment help determine if remediation is needed at any of the Area B study areas.

6.4.1 EPA Methods for Risk Characterization

This risk characterization presents a separate evaluation of noncancer and cancer effects. EPA methods distinguish cancer from noncancer effects because organisms typically respond differently following exposure to noncarcinogenic or carcinogenic agents.

The risk characterization requires that the potentially toxic effects associated with exposures to each of the COPCs be combined across environmental media and exposure routes. As described in the exposure assessment, it is reasonable to assume that a receptor could be exposed to COPCs through multiple exposure routes in multiple media. Thus, it is reasonable to combine the hazards and risks to develop receptor total risk and hazard estimates.

The cancer risk is the probability of excess (incremental) lifetime cancer risk (ELCR) for an individual that can be attributed to long-term exposure to chemicals. To derive an estimate of risk for low levels (i.e., below estimated risks of 0.01), the following equation is used:

$$\text{Risk} = \text{CDI} \times \text{SF}$$

Where:

Risk = A unitless probability of an individual developing cancer
CDI = Chronic daily intake averaged over 70 years (mg/kg-day)
SF = Slope factor, in $(\text{mg/kg-day})^{-1}$.

To derive an estimate of risk for high levels (i.e., above estimated risks of 0.01), a different equation is used, as follows:

$$\text{Risk} = 1 - \exp(-\text{CDI} \times \text{SF})$$

Where:

Risk = A unitless probability of an individual developing cancer
exp = Exponential

CDI = Chronic daily intake averaged over 70 years (mg/kg-day)
SF = Slope factor, in $(mg/kg\text{-}day)^{-1}$.

For multiple carcinogens, the risk for each compound has been summed to provide an overall estimate of risk for cancer effects (EPA 1989a).

For noncarcinogens, the chronic daily intake or dose experienced by the exposed individual is divided by the RfD. The resulting value is the HQ and is a measure of the possibility of adverse noncancer effects. To evaluate exposure from more than one noncarcinogen, the HQs are summed for all chemicals under evaluation to obtain the hazard index (HI).

After individual pathway risks are calculated, risks or HIs are combined across pathways for each receptor. A more detailed discussion of EPA's methods for risk characterization is presented in Appendix M, Section M.3.

6.4.2 Risk Characterization Methods for Lead

Health effects associated with low-level lead exposures include reproductive effects, nervous system effects, and learning disorders. Current toxicologic studies indicate that there may be no threshold of exposure to lead below which adverse effects do not occur. Given the uncertainty surrounding an acceptable exposure below which there would be no adverse effects for lead, EPA has withdrawn the RfD for lead from IRIS and HEAST. Lead also is classified as a B2 carcinogen (probable human carcinogen), but has no EPA-verified CSF.

At study areas where lead was not eliminated in the background comparison and the maximum detected concentration exceeded the 400 mg/kg screening level in soil or the 15 µg/L action level in drinking water (EPA 1995c), models were used to estimate blood levels of lead in human receptors. Measured soil and groundwater concentrations were used to run the models. The risk characterization for lead is based on two different uptake models—one for children in a residential setting and one for adult workers in an occupational setting. Modeling is necessary because blood lead levels in exposed populations were not directly measured.

The analysis for children was conducted using a biokinetic model developed by EPA for this purpose. This model, LEAD 0.99d (EPA 1994c), was developed by EPA to estimate blood lead levels in children (from the ages of 0 to 6 years) based on uptake of lead originating from various sources in the environment. This model is not applicable to children older than 6 years or to adults (EPA 1994d). Therefore, it was used to calculate blood lead levels only for the resident child receptor. Blood lead levels were not calculated for the recreational child receptor. No adjustment was made to the default absorption methodology used in the model. The model does not distinguish among different forms of lead.

For adult workers, SAIC used a model developed by EPA's Technical Review Workgroup for Lead. The model assumes a baseline blood level and uses various exposure parameters along

with a biokinetic slope factor to estimate blood lead levels. The model is designed to evaluate and protect the fetuses of pregnant working women and therefore incorporates a factor that converts the blood lead level in the mother to the blood lead level in the fetus. The basic equation uses the biokinetic slope factor to relate total intake of lead to blood lead. The equations used for evaluating lead exposures to adult workers are presented in Appendix M, Section M.4.

Both models provide default values for many of the parameters. In the case of the IEUBK model for children, these include dietary, maternal, and other sources of lead that are unrelated to site contamination, and the geometric standard deviation (GSD) for the blood lead uptake. The defaults were used, with the exception of the site-specific concentrations of lead in soil and groundwater. In the case of the model for adult workers, recommended default parameters and the site-specific concentration of lead in soil also were used. However, a range of values is provided for the GSD and background or baseline level of lead. The proper value to select from each of these ranges is supposed to be based on site-specific demographics such as age, gender, and race. Specifically precluding certain demographic segments from the risk assessment is questionable. Given the hypothetical nature of the future residential scenario, the most conservative default values were used in the model for adult workers. For both models, the arithmetic mean value was used as the exposure point concentration. The results of the lead analyses are presented in Section 6.4.4. Model parameters are provided in Appendix M.

6.4.3 Interpretation of Risk Assessment Results

EPA has established target risk levels for use in determining the need for remediation. The risk characterization calculates risks and compares these to target levels. If these levels are exceeded, the COCs responsible for the exceedances are identified. COCs are the chemicals carried into the FS and on which the remediation is focused. As opposed to COPCs, COCs are identified **after** the quantitative risk assessment has been conducted.

Using EPA Region IV guidance (EPA 1995c) and guidance presented in the *National Oil and Hazardous Substances Pollution Contingency Plan (NCP)* (EPA 1991c), COCs in the human health risk assessment are defined as chemicals that significantly contribute to a pathway that exceeds a 1×10^{-4} risk or an HI of 1. Chemicals are not considered COCs if their individual carcinogenic risk is less than 1×10^{-6} or their noncarcinogenic HQ is less than 0.1. For noncancer effects, if the pathway HI exceeds 1, chemicals are segregated according to which organ they target, and the pathway HI is recalculated. Chemicals contributing to target organ HIs (TOHIs) less than or equal to 1 are eliminated as COCs. COCs have been identified separately for each land use scenario and receptor, and may either independently exceed targets or combine to exceed targets.

Lead exposures are assumed to pose an unacceptable risk if the blood lead level of the resident child or the fetus of an adult female exceeds the proposed benchmark concentration developed by the Centers for Disease Control and Prevention (CDC). (Note that the adult model is designed to evaluate and protect the fetuses of pregnant working women.) Under this guideline, there must be a 95 percent probability that blood lead levels will not exceed 10 μg/dL in the fetus

of the pregnant woman worker. If blood lead levels exceed this guideline, lead is identified as a COC.

In accordance with EPA Region IV guidance (EPA 1995c), chemicals exceeding ARARs are also designated as COCs, along with any chemicals that exceed EPA targets as determined in the human health and ecological risk assessments. At Area B, groundwater concentrations were compared to State and Federal MCLs (see Table 6-1).

After the COCs have been identified, remedial goal options (RGOs) are calculated for each COC in accordance with EPA Region IV guidance (EPA 1995c). RGOs are discussed and presented in Section 6.7.

6.4.4 Results

This section discusses the RME risk estimates for the Area B study areas. Risks are presented separately for each study area. This section presents only RMEs; CTE risks are discussed in Section 6.5. For each study area, a risk characterization table summarizes the risks for all receptors and all media. If COCs were identified, subsequent tables present the risks associated with each COC by receptor. These tables do not show the risks for all COPCs because this information is presented in Appendix N.

In the following risk characterization summary tables, soil risks were calculated and are presented separately for surface and subsurface soils. In addition, combined risks (summing multiple chemicals, pathways, and media) were totaled separately for surface and subsurface soils. It is not appropriate to add the surface and subsurface soil risks together because a weighting factor that would portion exposure between the two soil horizons was not incorporated into the risk assessment. Note that residents were evaluated for exposure to subsurface soil because of the possibility of soil redistribution. During excavation and regrading, soils that were 1 to 10 feet BLS may be redistributed at the surface.

Groundwater risks are discussed separately and were not summed with the soil, sediment, or biota risks in the Risk Characterization Summary tables. The groundwater risks at Area B greatly exceed EPA targets for most of the exposure units. Summing HIs and cancer risks for groundwater and other media results in risks that exceed EPA targets for every exposure unit[1]. Therefore, risks are presented separately to more easily distinguish which risks are related to a given medium.

In a similar manner, when both site-specific soil and groundwater concentrations for lead are used in the models, blood lead levels exceed the CDC target for every study area due to the high concentrations of lead in the groundwater. In an effort to concentrate on lead problems associated with a specific medium, the lead model was first run using site-specific soil concentrations and model default groundwater concentrations and then repeated using site-specific groundwater

[1] Cancer risks are summed separately from noncancer risks.

concentrations and model default soil concentrations. The results of the lead analysis for all exposure units are provided in **Table 6-7**. Lead results also are discussed briefly in the following subsections where screening levels were exceeded.

6.4.4.1 Study Area 2 – Smokeless Powder Facility

The pathways evaluated at Study Area 2 are soil ingestion, dermal contact, and inhalation of suspended soil particulates for all receptors. The RME risk characterization summary for Study Area 2 is presented in **Table 6-8**, and COCs for each pathway and receptor are listed in **Tables 6-9** through **6-14**.

Industrial Scenario

For industrial workers exposed to surface soil, the combined cancer risk under RME assumptions is 8×10^{-4}, which is above the target cancer risk of 1×10^{-4}. The combined RME HI of 0.9 falls below the target HI of 1. The following COCs were identified for the industrial worker at Study Area 2 based on cancer effects:

- arsenic: surface soil ingestion cancer risk = 5×10^{-6}
  surface soil dermal contact cancer risk = 2×10^{-6}
- benzo(a)anthracene: surface soil ingestion cancer risk = 1×10^{-5}
  surface soil dermal contact cancer risk = 4×10^{-5}
- benzo(a)pyrene: surface soil ingestion cancer risk = 1×10^{-4}
  surface soil dermal contact cancer risk = 4×10^{-4}
- benzo(b)fluoranthene: surface soil ingestion cancer risk = 1×10^{-5}
  surface soil dermal contact cancer risk = 4×10^{-5}
- benzo(k)fluoranthene: surface soil dermal contact cancer risk = 2×10^{-6}
- dibenzo(a,h)anthracene: surface soil ingestion cancer risk = 3×10^{-5}
  surface soil dermal contact cancer risk = 1×10^{-4}
- indeno(1,2,3-cd)pyrene: surface soil ingestion cancer risk = 4×10^{-6}
  surface soil dermal contact cancer risk = 1×10^{-5}

Construction Scenario

For construction workers exposed to soil, the combined cancer risks under RME assumptions are 2×10^{-4} for surface soil exposure and 1×10^{-5} for subsurface soil exposure. The combined RME HI of 2 (for both surface and subsurface soil exposure) exceeds the target HI of 1.

Table 6-7. Summary of Lead Results
Mean Blood Lead Concentration at 95th Percentile (CDC Target = 10 μg/dL)

Exposure Unit	Fetus of Industrial Worker (μg/dL)	Fetus of Constr. Worker Surface Soil (μg/dL)	Fetus of Constr. Worker Subsurface Soil (μg/dL)	Resident Child Groundwater & Surface Soil (μg/dL)	Resident Child Groundwater & Subsurface Soil (μg/dL)
2 - Smokeless Powder Facility					
3 - Sanitary Landfill and Lead Facility					
4 - Manhattan Project Area	9	11	9	18	13
5 - Red Water Storage Basin					
6 - Southern TNT Manufacturing Area					
7 - Northern TNT Manufacturing Area					
8 - Acid/Organic Manufacturing Area	7	8	9	9	11
8 - Test pits					
9 - Aniline Sludge Basin					
9 - Tar				26	
9 - Sediment Beneath Tar					
10 East - Tetryl Manufacturing Area					
10 West - Tetryl Manufacturing Area	8	9		13	
16 - Flashing Ground	9	11	9	18	12
17 - Propellant Shipping Area					
18 - Blending Tower Area					
19 - Lead Facility	7	7		6	
20 - Rifle Powder Finishing Area					
21 - Red Water Ditch				6	
22 - Demolition Landfill	12	18	27	35	49
25 - Storage Battery/Demolition Debris					
26 - Crossover Ditch					
27 - Beaver Pond Drainage System					
CERFA - Building 6 - Coke Oven					
CERFA - Transformer Storage Bldg. & Utility Poles					
CERFA - Underground Storage Tanks					
CERFA - Gas Station					
CERFA - Fertilizer and Pesticide Storage					
Talladega Creek					
Groundwater - Areas 16 and 19				6	5
Groundwater - Main Industrial Area				39	39
Groundwater - Blending/Shipping Area				100	100
Groundwater - Smokeless Powder Area				18	17

CDC target is to mitigate lead exposures so that mean blood lead concentrations do not exceed 10 ug/dl 95 percent of the time.
CDC - Centers for Disease Control and Prevention
- Blood lead levels not evaluated due to lack of data or lead concentrations below screening levels

Table 6-8. RME Risk Characterization Summary for Study Area 02 (Current/Future and Future Land Uses)
Smokeless Powder Facility, Alabama Army Ammunition Plant, Childersburg, Alabama

Medium	Exposure Route	Cancer Risk: Industrial Worker	Cancer Risk: Construction Worker	Cancer Risk: Recreational Child	Cancer Risk: Recreational Adult	Cancer Risk: Residential Child	Cancer Risk: Residential Adult	Noncancer HI: Industrial Worker	Noncancer HI: Construction Worker	Noncancer HI: Recreational Child	Noncancer HI: Recreational Adult	Noncancer HI: Residential Child	Noncancer HI: Residential Adult
Surface Soil (0 to < 1 ft BLS)	Ingestion	2E-04 E	1E-04 B	1E-04 B	1E-04 B	2E-03 E	2E-03 E	2E-01 B	1E+00 B	9E-02 B	6E-02 B	4E+00 E	4E-01 B
	Dermal Contact	6E-04 E	5E-05 B	2E-04 E	2E-04 E	1E-03 E	1E-03 E	2E-01 B	2E-01 B	5E-02 B	5E-02 B	5E-01 B	3E-01 B
	Inhalation	2E-06 B	2E-07 B	4E-07 B	4E-07 B	5E-06 B	5E-06 B	5E-01 B	6E-01 B	1E-01 B	4E-02 B	2E+00 E	7E-01 B
	Subtotal	8E-04 E	2E-04 E	3E-04 E	3E-04 E	3E-03 E	3E-03 E	9E-01 B	2E+00 E	2E-01 B	2E-01 B	7E+00 E	1E+00 B
Subsurface Soil (1 to 10 ft BLS)	Ingestion	NA	1E-05 B	NA	NA	1E-04 B	1E-04 B	NA	1E+00 B	NA	NA	4E+00 E	4E-01 B
	Dermal Contact	NA	2E-06 B	NA	NA	4E-05 B	4E-05 B	NA	2E-01 B	NA	NA	5E-01 B	3E-01 B
	Inhalation	NA	6E-10 B	NA	NA	1E-08 B	1E-08 B	NA	8E-01	NA	NA	3E+00 E	9E-01 B
	Subtotal	NA	1E-05 B	NA	NA	2E-04 E	2E-04 E	NA	2E+00 E	NA	NA	8E+00 E	2E+00 E
Sediment	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface Water	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Groundwater	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Rabbit	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fish	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface Soil (0 to < 1 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								9E-01 B	2E+00 E	2E-01 B	2E-01 B	7E+00 E	1E+00 B
Combined Cancer Risk:		8E-04 E	2E-04 E	3E-04 E	3E-04 E	3E-03 E	3E-03 E						
Subsurface Soil (1 to 10 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	2E+00 E	NA	NA	8E+00 E	2E+00 E
Combined Cancer Risk:		NA	1E-05 B	NA	NA	2E-04 E	2E-04 E						

NA - pathway not evaluated or all detected chemicals eliminated as COPCs
0E+00 - pathway evaluated but no risks could be calculated due to lack of EPA-approved toxicity values
B - HI $\leq$ 1 or ELCR $\leq 10^{-4}$
E - HI > 1 or ELCR > 10^{-4}

Table 6-9. Summary of Receptor Risks and Hazards for COCs at Study Area 02
Reasonable Maximum Exposure
Smokeless Powder Facility, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Current/Future
Receptor Population: Industrial Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Soil	Smokeless Powder Facility	Aluminum	--	--	--	--	Alumimum	--	--	--	--	--
			Arsenic	5.415E-06	--	1.532E-06	6.947E-06	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			Benzo(a)anthracene	1.148E-05	--	4.296E-05	5.444E-05	Benzo(a)anthracene	--	--	--	--	--
			Benzo(a)pyrene	0.000115	--	0.000430	0.000544	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	1.148E-05	--	4.296E-05	5.444E-05	Benzo(b)fluoranthene	--	--	--	--	--
			Benzo(k)fluoranthene	--	--	--	--	Benzo(k)fluoranthene	--	--	--	--	--
			Dibenzo(a,h)anthracene	2.551E-05	--	9.546E-05	0.000121	Dibenzo(a,h)anthracene	--	--	--	--	--
			Indeno(1,2,3-cd)pyrene	3.827E-06	--	1.432E-05	1.815E-05	Indeno(1,2,3-cd)pyrene	--	--	--	--	--
			(Total)	0.000173	--	0.000627	0.000799	(Total)	--	--	--	--	--
	Air	Smokeless Powder Facility	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			Benzo(a)anthracene	--	--	--	--	Benzo(a)anthracene	--	--	--	--	--
			Benzo(a)pyrene	--	--	--	--	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	--	--	--	--	Benzo(b)fluoranthene	--	--	--	--	--
			Benzo(k)fluoranthene	--	--	--	--	Benzo(k)fluoranthene	--	--	--	--	--
			Dibenzo(a,h)anthracene	--	--	--	--	Dibenzo(a,h)anthracene	--	--	--	--	--
			Indeno(1,2,3-cd)pyrene	--	--	--	--	Indeno(1,2,3-cd)pyrene	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--

Table 6-10. Summary of Receptor Risks and Hazards for COCs at Study Area 02
Reasonable Maximum Exposure
Smokeless Powder Facility, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Soil	Smokeless Powder Facility	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	4.159E-06	--	1.226E-07	4.281E-06	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			Benzo(a)anthracene	8.816E-06	--	3.436E-06	1.225E-05	Benzo(a)anthracene	--	--	--	--	--
			Benzo(a)pyrene	8.816E-05	--	3.436E-05	0.000123	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	8.816E-06	--	3.436E-06	1.225E-05	Benzo(b)fluoranthene	--	--	--	--	--
			Benzo(k)fluoranthene	--	--	--	--	Benzo(k)fluoranthene	--	--	--	--	--
			Dibenzo(a,h)anthracene	1.959E-05	--	7.637E-06	2.723E-05	Dibenzo(a,h)anthracene	--	--	--	--	--
			Indeno(1,2,3-cd)pyrene	2.939E-06	--	1.145E-06	4.084E-06	Indeno(1,2,3-cd)pyrene	--	--	--	--	--
			(Total)	0.000132	--	5.014E-05	0.000183	(Total)	--	--	--	--	--
	Air	Smokeless Powder Facility	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			Benzo(a)anthracene	--	--	--	--	Benzo(a)anthracene	--	--	--	--	--
			Benzo(a)pyrene	--	--	--	--	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	--	--	--	--	Benzo(b)fluoranthene	--	--	--	--	--
			Benzo(k)fluoranthene	--	--	--	--	Benzo(k)fluoranthene	--	--	--	--	--
			Dibenzo(a,h)anthracene	--	--	--	--	Dibenzo(a,h)anthracene	--	--	--	--	--
			Indeno(1,2,3-cd)pyrene	--	--	--	--	Indeno(1,2,3-cd)pyrene	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
Subsurface Soil	Soil	Smokeless Powder Facility	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			2,4-Dinitrotoluene	--	--	--	--	2,4-Dinitrotoluene	--	--	--	--	--
			Benzo(a)pyrene	--	--	--	--	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	--	--	--	--	Benzo(b)fluoranthene	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
	Air	Smokeless Powder Facility	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			2,4-Dinitrotoluene	--	--	--	--	2,4-Dinitrotoluene	--	--	--	--	--
			Benzo(a)pyrene	--	--	--	--	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	--	--	--	--	Benzo(b)fluoranthene	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--

Table 6-11. Summary of Receptor Risks and Hazards for COCs at Study Area 02
Reasonable Maximum Exposure
Smokeless Powder Facility, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Recreational User
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Soil	Smokeless Powder Facility	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	3.427E-06	--	4.289E-07	3.856E-06	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			Benzo(a)anthracene	7.265E-06	--	1.203E-05	1.929E-05	Benzo(a)anthracene	--	--	--	--	--
			Benzo(a)pyrene	7.265E-05	--	0.000120	0.000193	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	7.265E-06	--	1.203E-05	1.929E-05	Benzo(b)fluoranthene	--	--	--	--	--
			Benzo(k)fluoranthene	--	--	--	--	Benzo(k)fluoranthene	--	--	--	--	--
			Dibenzo(a,h)anthracene	1.615E-05	--	2.673E-05	4.287E-05	Dibenzo(a,h)anthracene	--	--	--	--	--
			Indeno(1,2,3-cd)pyrene	2.422E-06	--	4.009E-06	6.431E-06	Indeno(1,2,3-cd)pyrene	--	--	--	--	--
			(Total)	0.000109	--	0.000175	0.000285	(Total)	--	--	--	--	--
	Air	Smokeless Powder Facility	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			Benzo(a)anthracene	--	--	--	--	Benzo(a)anthracene	--	--	--	--	--
			Benzo(a)pyrene	--	--	--	--	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	--	--	--	--	Benzo(b)fluoranthene	--	--	--	--	--
			Benzo(k)fluoranthene	--	--	--	--	Benzo(k)fluoranthene	--	--	--	--	--
			Dibenzo(a,h)anthracene	--	--	--	--	Dibenzo(a,h)anthracene	--	--	--	--	--
			Indeno(1,2,3-cd)pyrene	--	--	--	--	Indeno(1,2,3-cd)pyrene	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--

Table 6-12. Summary of Receptor Risks and Hazards for COCs at Study Area 02
Reasonable Maximum Exposure
Smokeless Powder Facility, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Recreational User
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Soil	Smokeless Powder Facility	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	3.427E-06	--	4.289E-07	3.856E-06	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			Benzo(a)anthracene	7.265E-06	--	1.203E-05	1.929E-05	Benzo(a)anthracene	--	--	--	--	--
			Benzo(a)pyrene	7.265E-05	--	0.000120	0.000193	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	7.265E-06	--	1.203E-05	1.929E-05	Benzo(b)fluoranthene	--	--	--	--	--
			Benzo(k)fluoranthene	--	--	--	--	Benzo(k)fluoranthene	--	--	--	--	--
			Dibenzo(a,h)anthracene	1.615E-05	--	2.673E-05	4.287E-05	Dibenzo(a,h)anthracene	--	--	--	--	--
			Indeno(1,2,3-cd)pyrene	2.422E-06	--	4.009E-06	6.431E-06	Indeno(1,2,3-cd)pyrene	--	--	--	--	--
			(Total)	0.000109	--	0.000175	0.000285	(Total)	--	--	--	--	--
	Air	Smokeless Powder Facility	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			Benzo(a)anthracene	--	--	--	--	Benzo(a)anthracene	--	--	--	--	--
			Benzo(a)pyrene	--	--	--	--	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	--	--	--	--	Benzo(b)fluoranthene	--	--	--	--	--
			Benzo(k)fluoranthene	--	--	--	--	Benzo(k)fluoranthene	--	--	--	--	--
			Dibenzo(a,h)anthracene	--	--	--	--	Dibenzo(a,h)anthracene	--	--	--	--	--
			Indeno(1,2,3-cd)pyrene	--	--	--	--	Indeno(1,2,3-cd)pyrene	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--

Table 6-13. Summary of Receptor Risks and Hazards for COCs at Study Area 02
Reasonable Maximum Exposure
Smokeless Powder Facility, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Soil	Smokeless Powder Facility	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	4.852E-05	--	2.892E-06	5.141E-05	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	1.74	--	0.117	1.86
			Manganese	--	--	--	--	Manganese	CNS	0.693	--	0.174	0.867
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			Benzo(a)anthracene	0.000103	--	8.107E-05	0.000184	Benzo(a)anthracene	--	--	--	--	--
			Benzo(a)pyrene	0.00103	--	0.000811	0.00184	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	0.000103	--	8.107E-05	0.000184	Benzo(b)fluoranthene	--	--	--	--	--
			Benzo(k)fluoranthene	5.714E-06	--	4.504E-06	1.022E-05	Benzo(k)fluoranthene	--	--	--	--	--
			Dibenzo(a,h)anthracene	0.000229	--	0.000180	0.000409	Dibenzo(a,h)anthracene	--	--	--	--	--
			Indeno(1,2,3-cd)pyrene	3.429E-05	--	2.702E-05	6.131E-05	Indeno(1,2,3-cd)pyrene	--	--	--	--	--
			(Total)	0.00155	--	0.00119	0.00274	(Total)	--	2.43	--	0.291	2.73
	Air	Smokeless Powder Facility	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	1.479E-06	--	1.479E-06	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	1.890E-06	--	1.890E-06	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	--	2.36	--	2.36
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			Benzo(a)anthracene	--	--	--	--	Benzo(a)anthracene	--	--	--	--	--
			Benzo(a)pyrene	--	1.327E-06	--	1.327E-06	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	--	--	--	--	Benzo(b)fluoranthene	--	--	--	--	--
			Benzo(k)fluoranthene	--	--	--	--	Benzo(k)fluoranthene	--	--	--	--	--
			Dibenzo(a,h)anthracene	--	--	--	--	Dibenzo(a,h)anthracene	--	--	--	--	--
			Indeno(1,2,3-cd)pyrene	--	--	--	--	Indeno(1,2,3-cd)pyrene	--	--	--	--	--
			(Total)	--	4.696E-06	--	4.696E-06	(Total)	--	--	2.36	--	2.36
Subsurface Soil	Soil	Smokeless Powder Facility	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	2.05	--	0.138	2.19
			Manganese	--	--	--	--	Manganese	CNS	0.906	--	0.228	1.13
			2,4-Dinitrotoluene	0.000106	--	3.039E-05	0.000136	2,4-Dinitrotoluene	CNS	0.635	--	0.0751	0.710
			Benzo(a)pyrene	9.714E-06	--	7.657E-06	1.737E-05	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	1.486E-06	--	1.171E-06	2.657E-06	Benzo(b)fluoranthene	--	--	--	--	--
			(Total)	0.000117	--	3.922E-05	0.000156	(Total)	--	3.60	--	0.440	4.04
	Air	Smokeless Powder Facility	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	--	3.08	--	3.08
			2,4-Dinitrotoluene	--	--	--	--	2,4-Dinitrotoluene	--	--	--	--	--
			Benzo(a)pyrene	--	--	--	--	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	--	--	--	--	Benzo(b)fluoranthene	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	3.08	--	3.08

Table 6-14. Summary of Receptor Risks and Hazards for COCs at Study Area 02
Reasonable Maximum Exposure
Smokeless Powder Facility, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Soil	Smokeless Powder Facility	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	4.852E-05	--	2.892E-06	5.141E-05	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			Benzo(a)anthracene	0.000103	--	8.107E-05	0.000184	Benzo(a)anthracene	--	--	--	--	--
			Benzo(a)pyrene	0.00103	--	0.000811	0.00184	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	0.000103	--	8.107E-05	0.000184	Benzo(b)fluoranthene	--	--	--	--	--
			Benzo(k)fluoranthene	5.714E-06	--	4.504E-06	1.022E-05	Benzo(k)fluoranthene	--	--	--	--	--
			Dibenzo(a,h)anthracene	0.000229	--	0.000180	0.000409	Dibenzo(a,h)anthracene	--	--	--	--	--
			Indeno(1,2,3-cd)pyrene	3.429E-05	--	2.702E-05	6.131E-05	Indeno(1,2,3-cd)pyrene	--	--	--	--	--
			(Total)	0.00155	--	0.00119	0.00274	(Total)	--	--	--	--	--
	Air	Smokeless Powder Facility	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	1.479E-06	--	1.479E-06	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	1.890E-06	--	1.890E-06	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			Benzo(a)anthracene	--	--	--	--	Benzo(a)anthracene	--	--	--	--	--
			Benzo(a)pyrene	--	1.327E-06	--	1.327E-06	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	--	--	--	--	Benzo(b)fluoranthene	--	--	--	--	--
			Benzo(k)fluoranthene	--	--	--	--	Benzo(k)fluoranthene	--	--	--	--	--
			Dibenzo(a,h)anthracene	--	--	--	--	Dibenzo(a,h)anthracene	--	--	--	--	--
			Indeno(1,2,3-cd)pyrene	--	--	--	--	Indeno(1,2,3-cd)pyrene	--	--	--	--	--
			(Total)	--	4.696E-06	--	4.696E-06	(Total)	--	--	--	--	--
Subsurface Soil	Soil	Smokeless Powder Facility	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			2,4-Dinitrotoluene	0.000106	--	3.039E-05	0.000136	2,4-Dinitrotoluene	--	--	--	--	--
			Benzo(a)pyrene	9.714E-06	--	7.657E-06	1.737E-05	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	1.486E-06	--	1.171E-06	2.657E-06	Benzo(b)fluoranthene	--	--	--	--	--
			(Total)	0.000117	--	3.922E-05	0.000156	(Total)	--	--	--	--	--
	Air	Smokeless Powder Facility	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			2,4-Dinitrotoluene	--	--	--	--	2,4-Dinitrotoluene	--	--	--	--	--
			Benzo(a)pyrene	--	--	--	--	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	--	--	--	--	Benzo(b)fluoranthene	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--

However, noncancer effects were segregated according to target organ. The medium TOHIs for surface and subsurface soils do not exceed the target HI. Therefore, no COCs were identified based on noncancer effects. The following COCs were identified for the construction worker at Study Area 2 based on cancer effects:

- arsenic: surface soil ingestion cancer risk = 4×10^{-6}
- benzo(a)anthracene: surface soil ingestion cancer risk = 9×10^{-6}
  surface soil dermal contact cancer risk = 3×10^{-6}
- benzo(a)pyrene: surface soil ingestion cancer risk = 9×10^{-5}
  surface soil dermal contact cancer risk = 3×10^{-5}
- benzo(b)fluoranthene: surface soil ingestion cancer risk = 9×10^{-6}
  surface soil dermal contact cancer risk = 3×10^{-6}
- dibenzo(a,h)anthracene: surface soil ingestion cancer risk = 2×10^{-5}
  surface soil dermal contact cancer risk = 8×10^{-6}
- indeno(1,2,3-cd)pyrene: surface soil ingestion cancer risk = 3×10^{-6}
  surface soil dermal contact cancer risk = 1×10^{-6}

Recreational Scenario

For recreational receptors exposed to surface soil, the combined RME cancer risk for the integrated child or adult receptor is 3×10^{-4}, which is above the target cancer risk of 1×10^{-4}. The combined RME HIs of 0.2 for the child and 0.2 for the adult fall below the target HI of 1. The following COCs were identified for the integrated child or adult recreational receptor at Study Area 2 based on cancer effects:

- arsenic: surface soil ingestion cancer risk = 3×10^{-6}
- benzo(a)anthracene: surface soil ingestion cancer risk = 7×10^{-6}
  surface soil dermal contact cancer risk = 1×10^{-5}
- benzo(a)pyrene: surface soil ingestion cancer risk = 7×10^{-5}
  surface soil dermal contact cancer risk = 1×10^{-4}
- benzo(b)fluoranthene: surface soil ingestion cancer risk = 7×10^{-6}
  surface soil dermal contact cancer risk = 1×10^{-5}
- dibenzo(a,h)anthracene: surface soil ingestion cancer risk = 2×10^{-5}
  surface soil dermal contact cancer risk = 3×10^{-5}

- indeno(1,2,3-cd)pyrene: surface soil ingestion cancer risk = 2×10^{-6}
  surface soil dermal contact cancer risk = 4×10^{-6}

Residential Scenario

The combined RME cancer risks for the integrated child or adult resident are 3×10^{-3} for exposure to surface soil and 2×10^{-4} for exposure to subsurface soil. Both are above the target cancer risk of 1×10^{-4}. For noncancer effects, the combined RME HIs are 7 and 8 (surface and subsurface soil exposures, respectively for the child) and 1 and 2 (surface and subsurface soil exposures, respectively for the adult). Noncancer effects were segregated according to target organ. In both surface and subsurface soils, the medium TOHI for the central nervous system exceeds the target HI for the child but not for the adult. The following COCs were identified for residents at Study Area 2 based on cancer and noncancer effects:

- arsenic: surface soil ingestion cancer risk = 5×10^{-5}
  surface soil dermal contact cancer risk = 3×10^{-6}
  surface soil inhalation cancer risk = 1×10^{-6}
- chromium, hexavalent: surface soil inhalation cancer risk = 2×10^{-6}
- iron: surface soil ingestion HQ = 2 (child)
  surface soil dermal contact HQ = 0.1 (child)
  subsurface soil ingestion HQ = 2 (child)
  subsurface soil dermal contact HQ = 0.1 (child)
- manganese: surface soil ingestion HQ = 0.7 (child)
  surface soil dermal contact HQ = 0.2 (child)
  surface soil inhalation HQ = 2 (child)
  subsurface soil ingestion HQ = 0.9 (child)
  subsurface soil dermal contact HQ = 0.2 (child)
  subsurface soil inhalation HQ = 3 (child)
- 2,4-dinitrotoluene: subsurface soil ingestion cancer risk = 1×10^{-4}
  subsurface soil dermal contact cancer risk = 3×10^{-5}
  subsurface soil ingestion HQ = 0.6 (child)
- benzo(a)anthracene: surface soil ingestion cancer risk = 1×10^{-4}
  surface soil dermal contact cancer risk = 8×10^{-5}
- benzo(a)pyrene: surface soil ingestion cancer risk = 1×10^{-3}
  surface soil dermal contact cancer risk = 8×10^{-4}
  surface soil inhalation cancer risk = 1×10^{-6}

subsurface soil ingestion cancer risk = 1×10^{-5}
subsurface soil dermal contact cancer risk = 8×10^{-6}

- benzo(b)fluoranthene: surface soil ingestion cancer risk = 1×10^{-4}
  surface soil dermal contact cancer risk = 8×10^{-5}
  subsurface soil ingestion cancer risk = 1×10^{-6}
  subsurface soil dermal contact cancer risk = 1×10^{-6}
- benzo(k)fluoranthene: surface soil ingestion cancer risk = 6×10^{-6}
  surface soil dermal contact cancer risk = 5×10^{-6}
- dibenzo(a,h)anthracene: surface soil ingestion cancer risk = 2×10^{-4}
  surface soil dermal contact cancer risk = 2×10^{-4}
- indeno(1,2,3-cd)pyrene: surface soil ingestion cancer risk = 3×10^{-5}
  surface soil dermal contact cancer risk = 3×10^{-5}

6.4.4.2 Study Area 3 – Sanitary Landfill and Lead Facility

The pathways evaluated at Study Area 3 are soil ingestion, dermal contact, and inhalation of suspended soil particulates for all receptors. The RME risk characterization summary for Study Area 3 is presented in **Table 6-15**, and COCs are listed in **Table 6-16**.

Industrial Scenario

For industrial workers exposed to surface soil, the combined cancer risk under RME assumptions is 2×10^{-5}, which falls below the target cancer risk of 1×10^{-4}. The combined RME HI of 0.4 falls below the target HI of 1. Therefore, no COCs were identified for the industrial worker at Study Area 3.

Construction Scenario

For construction workers exposed to soil, the combined cancer risks under RME assumptions are 1×10^{-5} for surface soil exposure and 3×10^{-8} for subsurface soil exposure. Both fall below the target cancer risk of 1×10^{-4}. The combined RME HI of 2 for surface soil exposure exceeds the target HI of 1. For subsurface soil exposures, the combined RME HI of 1 equals but does not exceed the target HI. In surface soil, noncancer effects were segregated according to target organ. The medium TOHIs for surface soil do not exceed the target HI. Therefore, no COCs were identified for the construction worker at Study Area 3.

Table 6-15. RME Risk Characterization Summary for Study Area 03 (Current/Future and Future Land Uses) Sanitary Landfill and Lead Facility, Alabama Army Ammunition Plant, Childersburg, Alabama

Medium	Exposure Route	Cancer Risk						Noncancer HI					
		Industrial Worker	Construction Worker	Recreational Child	Recreational Adult	Residential Child	Residential Adult	Industrial Worker	Construction Worker	Recreational Child	Recreational Adult	Residential Child	Residential Adult
Surface Soil (0 to <1 ft BLS)	Ingestion	1E-05 B	1E-05 B	8E-06 B	8E-06 B	1E-04 B	1E-04 B	2E-01 B	2E+00 E	1E-01 B	8E-02 B	5E+00 E	5E-01 B
	Dermal Contact	7E-06 B	6E-07 B	2E-06 B	2E-06 B	1E-05 B	1E-05 B	2E-01 B	2E-01 B	4E-02 B	4E-02 B	4E-01 B	3E-01 B
	Inhalation	1E-06 B	1E-07 B	2E-07 B	2E-07 B	3E-06 B	3E-06 B	NA	NA	NA	NA	NA	NA
	Subtotal	**2E-05 B**	**1E-05 B**	**1E-05 B**	**1E-05 B**	**1E-04 B**	**1E-04 B**	**4E-01 B**	**2E+00 E**	**2E-01 B**	**1E-01 B**	**5E+00 E**	**8E-01 B**
Subsurface Soil (1 to 10 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	NA	1E+00 B	NA	NA	3E+00 E	3E-01 B
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	1E-01 B	NA	NA	3E-01 B	2E-01 B
	Inhalation	NA	3E-08 B	NA	NA	9E-07 B	9E-07 B	NA	3E-01	NA	NA	1E+00 B	3E-01 B
	Subtotal	**NA**	**3E-08 B**	**NA**	**NA**	**9E-07 B**	**9E-07 B**	**NA**	**1E+00 B**	**NA**	**NA**	**4E+00 E**	**8E-01 B**
Sediment	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Surface Water	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Groundwater	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Rabbit	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Fish	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Surface Soil (0 to <1 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								4E-01 B	2E+00 E	2E-01 B	1E-01 B	5E+00 E	8E-01 B
Combined Cancer Risk:		2E-05 B	1E-05 B	1E-05 B	1E-05 B	1E-04 B	1E-04 B						
Subsurface Soil (1 to 10 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	1E+00 B	NA	NA	4E+00 E	8E-01 B
Combined Cancer Risk:		NA	3E-08 B	NA	NA	9E-07 B	9E-07 B						

NA - pathway not evaluated or all detected chemicals eliminated as COPCs
0E+00 - pathway evaluated but no risks could be calculated due to lack of EPA-approved toxicity values
B - HI $\leq$ 1 or ELCR $\leq 10^{-4}$
E - HI > 1 or ELCR > 10^{-4}

Table 6-16. Summary of Receptor Risks and Hazards for COCs at Study Area 03
Reasonable Maximum Exposure
Sanitary Landfill and Lead Facility, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Soil	Sanitary Landfill and Lead Facility	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	skin	1.84	--	0.0451	1.89
			Iron	--	--	--	--	Iron	--	2.60	--	0.174	2.77
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			Benzo(a)pyrene	--	--	--	--	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	--	--	--	--	Benzo(b)fluoranthene	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	4.44	--	0.219	4.66
	Air	Sanitary Landfill and Lead Facility	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			Benzo(a)pyrene	--	--	--	--	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	--	--	--	--	Benzo(b)fluoranthene	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
Subsurface Soil	Soil	Sanitary Landfill and Lead Facility	Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	2.63	--	0.176	2.81
			Manganese	--	--	--	--	Manganese	CNS	0.324	--	0.0813	0.405
			(Total)	--	--	--	--	(Total)	--	2.95	--	0.258	3.21
	Air	Sanitary Landfill and Lead Facility	Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	--	1.10	--	1.10
			(Total)	--	--	--	--	(Total)	--	--	1.10	--	1.10

Recreational Scenario

For recreational receptors exposed to surface soil, the combined RME cancer risk for the integrated child or adult receptor is 1×10^{-5}, which is below the target cancer risk of 1×10^{-4}. The combined RME HIs of 0.2 for the child and 0.1 for the adult fall below the target HI of 1. Therefore, no COCs were identified for recreational receptors at Study Area 3.

Residential Scenario

The combined RME cancer risks for the integrated child or adult resident are 1×10^{-4} for exposure to surface soil and 9×10^{-7} for exposure to subsurface soil. Both are at or below the target cancer risk of 1×10^{-4}. For noncancer effects, the combined RME HIs are 5 and 4 (surface and subsurface soil exposures, respectively for the child) and 0.8 (surface and subsurface soil exposures for the adult). Noncancer effects were segregated according to target organ. For the resident child, the medium TOHI for the skin exceeds the target HI in surface soil. The following COCs were identified for residents at Study Area 3 based on noncancer effects:

- arsenic: surface soil ingestion HQ = 2 (child)
- iron: surface soil ingestion HQ = 3 (child)
surface soil dermal contact HQ = 0.2 (child)
subsurface soil ingestion HQ = 3 (child)
subsurface soil dermal contact HQ = 0.2 (child)
- manganese: subsurface soil ingestion HQ = 0.3 (child)
subsurface soil inhalation HQ = 1 (child)

6.4.4.3 Study Area 4 – Manhattan Project Area

The pathways evaluated at Study Area 4 are soil ingestion, dermal contact, and inhalation of suspended soil particulates for all receptors. The RME risk characterization summary for Study Area 4 is presented in **Table 6-17**.

The maximum detected concentration of lead in soil at Study Area 4 exceeds the 400 ppm screening level in surface and subsurface soils (EPA 1995c). Therefore, models were used to estimate blood lead levels in resident children, industrial workers, and construction workers.

Industrial Scenario

For industrial workers exposed to surface soil, the combined cancer risk under RME assumptions is 1×10^{-5}, which falls below the target cancer risk of 1×10^{-4}. The combined RME HI

Table 6-17. RME Risk Characterization Summary for Study Area 04 (Current/Future and Future Land Uses) Manhattan Project Area, Alabama Army Ammunition Plant, Childersburg, Alabama

Medium	Exposure Route	Cancer Risk: Industrial Worker	Cancer Risk: Construction Worker	Cancer Risk: Recreational Child	Cancer Risk: Recreational Adult	Cancer Risk: Residential Child	Cancer Risk: Residential Adult	Noncancer HI: Industrial Worker	Noncancer HI: Construction Worker	Noncancer HI: Recreational Child	Noncancer HI: Recreational Adult	Noncancer HI: Residential Child	Noncancer HI: Residential Adult
Surface Soil (0 to <1 ft BLS)	Ingestion	2E-06 B	2E-06 B	1E-06 B	1E-06 B	2E-05 B	2E-05 B	1E-02 B	1E-01 B	9E-03 B	6E-03 B	4E-01 B	4E-02 B
	Dermal Contact	8E-06 B	6E-07 B	2E-06 B	2E-06 B	1E-05 B	1E-05 B	2E-02 B	2E-02 B	4E-03 B	3E-03 B	4E-02 B	2E-02 B
	Inhalation	1E-08 B	9E-10 B	2E-09 B	2E-09 B	2E-08 B	2E-08 B	NA	NA	NA	NA	NA	NA
	Subtotal	**1E-05 B**	**2E-06 B**	**4E-06 B**	**4E-06 B**	**3E-05 B**	**3E-05 B**	**3E-02 B**	**1E-01 B**	**1E-02 B**	**9E-03 B**	**4E-01 B**	**6E-02 B**
Subsurface Soil (1 to 10 ft BLS)	Ingestion	NA	4E-07 B	NA	NA	5E-06 B	5E-06 B	NA	4E-02 B	NA	NA	1E-01 B	1E-02 B
	Dermal Contact	NA	2E-07 B	NA	NA	4E-06 B	4E-06 B	NA	4E-02 B	NA	NA	1E-01 B	6E-02 B
	Inhalation	NA	2E-10 B	NA	NA	7E-09 B	7E-09 B	NA	2E-04	NA	NA	7E-04 B	2E-04 B
	Subtotal	**NA**	**6E-07 B**	**NA**	**NA**	**9E-06 B**	**9E-06 B**	**NA**	**8E-02 B**	**NA**	**NA**	**2E-01 B**	**7E-02 B**
Sediment	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface Water	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Groundwater	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Rabbit	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fish	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface Soil (0 to <1 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								3E-02 B	1E-01 B	1E-02 B	9E-03 B	4E-01 B	6E-02 B
Combined Cancer Risk:		1E-05 B	2E-06 B	4E-06 B	4E-06 B	3E-05 B	3E-05 B						
Subsurface Soil (1 to 10 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	8E-02 B	NA	NA	2E-01 B	7E-02 B
Combined Cancer Risk:		NA	6E-07 B	NA	NA	9E-06 B	9E-06 B						

NA - pathway not evaluated or all detected chemicals eliminated as COPCs
0E+00 - pathway evaluated but no risks could be calculated due to lack of EPA-approved toxicity values
B - HI $\leq$ 1 or ELCR $\leq 10^{-4}$
E - HI > 1 or ELCR > 10^{-4}

of 0.03 falls below the target HI of 1. The 95th percentile mean blood lead concentration in the fetus of the industrial worker is 9 μg/dL, which is below the CDC target of 10 μg/dL. Therefore, no COCs were identified for the industrial worker at Study Area 4.

Construction Scenario

For construction workers exposed to soil, the combined cancer risks under RME assumptions are 2×10^{-6} for surface soil exposure and 6×10^{-7} for subsurface soil exposure. Both fall below the target cancer risk of 1×10^{-4}. The combined RME HIs of 0.1 for surface soil exposure and 0.08 for subsurface soil exposure fall below the target HI of 1. The 95th percentile mean blood lead concentration in the fetus of the construction worker is 11 μg/dL for surface soil exposure and 9 μg/dL for subsurface soil exposure. The former is above the CDC target of 10 μg/dL. Therefore, the following COC was identified for the construction worker at Study Area 4:

- lead: surface soil, 95th percentile mean blood lead level = 11 μg/dL

Recreational Scenario

For recreational receptors exposed to surface soil, the combined RME cancer risk for the integrated child or adult receptor is 4×10^{-6}, which is below the target cancer risk of 1×10^{-4}. The combined RME HIs of 0.01 for the child and 0.009 for the adult fall below the target HI of 1. Therefore, no COCs were identified for recreational receptors at Study Area 4.

Residential Scenario

The combined RME cancer risks for the integrated child or adult resident are 3×10^{-5} for exposure to surface soil and 9×10^{-6} for exposure to subsurface soil. Both fall below the target cancer risk of 1×10^{-4}. For noncancer effects, the combined RME HIs are 0.4 and 0.2 (surface and subsurface soil exposures, respectively for the child) and 0.06 and 0.07 (surface and subsurface soil exposures, respectively for the adult). All are below the target HI of 1. The 95th percentile mean blood lead concentration in the resident child is 18 μg/dL for exposure to surface soil and 13 μg/dL for exposure to subsurface soil, both of which are above the CDC target of 10 μg/dL. Therefore, the following COC was identified for the resident child at Study Area 4:

- lead: surface soil, 95th percentile mean blood lead level = 18 μg/dL
  subsurface soil, 95th percentile mean blood lead level = 13 μg/dL

6.4.4.4 Study Area 5 – Red Water Storage Basin

The pathways evaluated at Study Area 5 are sediment ingestion and dermal contact for recreational and residential receptors. All detected chemicals were eliminated as COPCs in the background comparison and RBC screen. Therefore, risks at Study Area 5 are insignificant.

6.4.4.5 Study Area 6 – Southern TNT Manufacturing Area

The pathways evaluated at Study Area 6 are soil ingestion, dermal contact, and inhalation of suspended soil particulates for all receptors. The RME risk characterization summary for Study Area 6 is presented in **Table 6-18**.

Industrial Scenario

For industrial workers exposed to surface soil, the combined cancer risk under RME assumptions is 1×10^{-7}, which falls below the target cancer risk of 1×10^{-4}. The combined RME HI of 2×10^{-4} falls below the target HI of 1. Therefore, no COCs were identified for the industrial worker at Study Area 6.

Construction Scenario

For construction workers exposed to soil, the combined cancer risks under RME assumptions are 3×10^{-8} for surface soil exposure and 1×10^{-6} for subsurface soil exposure. Both fall below the target cancer risk of 1×10^{-4}. The combined RME HIs of 8×10^{-4} for surface soil exposure and 0.2 for subsurface soil exposure fall below the target HI of 1. Therefore, no COCs were identified for the construction worker at Study Area 6.

Recreational Scenario

For recreational receptors exposed to surface soil, the combined RME cancer risk for the integrated child or adult receptor is 4×10^{-8}, which is below the target cancer risk of 1×10^{-4}. The combined RME HIs of 7×10^{-5} for the child and 6×10^{-5} for the adult fall below the target HI of 1. Therefore, no COCs were identified for recreational receptors at Study Area 6.

Residential Scenario

The combined RME cancer risks for the integrated child or adult resident are 4×10^{-7} for exposure to surface soil and 1×10^{-5} for exposure to subsurface soil. Both fall below the target cancer risk of 1×10^{-4}. For noncancer effects, the combined RME HIs are 0.002 and 0.4 (surface and subsurface soil exposures, respectively for the child) and 4×10^{-4} and 0.08 (surface and subsurface soil exposures, respectively for the adult). All are below the target HI of 1. Therefore, no COCs were identified for residents at Study Area 6.

6.4.4.6 Study Area 7 – Northern TNT Manufacturing Area

The pathways evaluated at Study Area 7 are soil ingestion, dermal contact, and inhalation of suspended soil particulates for all receptors. The RME risk characterization summary for Study Area 7 is presented in **Table 6-19**, and COCs are listed in **Table 6-20.**

Table 6-18. RME Risk Characterization Summary for Study Area 06 (Current/Future and Future Land Uses) Southern TNT Manufacturing Area, Alabama Army Ammunition Plant, Childersburg, Alabama

Medium	Exposure Route	Cancer Risk: Industrial Worker	Cancer Risk: Construction Worker	Cancer Risk: Recreational Child	Cancer Risk: Recreational Adult	Cancer Risk: Residential Child	Cancer Risk: Residential Adult	Noncancer HI: Industrial Worker	Noncancer HI: Construction Worker	Noncancer HI: Recreational Child	Noncancer HI: Recreational Adult	Noncancer HI: Residential Child	Noncancer HI: Residential Adult
Surface Soil (0 to <1 ft BLS)	Ingestion	3E-08 B	2E-08 B	2E-08 B	2E-08 B	3E-07 B	3E-07 B	6E-05 B	6E-04 B	4E-05 B	3E-05 B	2E-03 B	2E-04 B
	Dermal Contact	7E-08 B	6E-09 B	2E-08 B	2E-08 B	1E-07 B	1E-07 B	2E-04 B	2E-04 B	3E-05 B	3E-05 B	3E-04 B	2E-04 B
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**1E-07 B**	**3E-08 B**	**4E-08 B**	**4E-08 B**	**4E-07 B**	**4E-07 B**	**2E-04 B**	**8E-04 B**	**7E-05 B**	**6E-05 B**	**2E-03 B**	**4E-04 B**
Subsurface Soil (1 to 10 ft BLS)	Ingestion	NA	7E-07 B	NA	NA	8E-06 B	8E-06 B	NA	1E-01 B	NA	NA	4E-01 B	4E-02 B
	Dermal Contact	NA	3E-07 B	NA	NA	6E-06 B	6E-06 B	NA	3E-02 B	NA	NA	6E-02 B	4E-02 B
	Inhalation	NA	4E-10 B	NA	NA	1E-08 B	1E-08 B	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**1E-06 B**	**NA**	**NA**	**1E-05 B**	**1E-05 B**	**NA**	**2E-01 B**	**NA**	**NA**	**4E-01 B**	**8E-02 B**
Sediment	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Surface Water	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Groundwater	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Rabbit	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Fish	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Surface Soil (0 to <1 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								2E-04 B	8E-04 B	7E-05 B	6E-05 B	2E-03 B	4E-04 B
Combined Cancer Risk:		1E-07 B	3E-08 B	4E-08 B	4E-08 B	4E-07 B	4E-07 B						
Subsurface Soil (1 to 10 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	2E-01 B	NA	NA	4E-01 B	8E-02 B
Combined Cancer Risk:		NA	1E-06 B	NA	NA	1E-05 B	1E-05 B						

NA - pathway not evaluated or all detected chemicals eliminated as COPCs
0E+00 - pathway evaluated but no risks could be calculated due to lack of EPA-approved toxicity values
B - HI ≤ 1 or ELCR ≤ 10^{-4}
E - HI > 1 or ELCR > 10^{-4}

Table 6-19. RME Risk Characterization Summary for Study Area 07 (Current/Future and Future Land Uses)
Northern TNT Manufacturing Area, Alabama Army Ammunition Plant, Childersburg, Alabama

Medium	Exposure Route	Cancer Risk: Industrial Worker	Cancer Risk: Construction Worker	Cancer Risk: Recreational Child	Cancer Risk: Recreational Adult	Cancer Risk: Residential Child	Cancer Risk: Residential Adult	Noncancer HI: Industrial Worker	Noncancer HI: Construction Worker	Noncancer HI: Recreational Child	Noncancer HI: Recreational Adult	Noncancer HI: Residential Child	Noncancer HI: Residential Adult
Surface Soil (0 to <1 ft BLS)	Ingestion	7E-08 B	6E-08 B	5E-08 B	5E-08 B	6E-07 B	6E-07 B	5E-04 B	4E-03 B	3E-04 B	2E-04 B	1E-02 B	1E-03 B
	Dermal Contact	1E-07 B	8E-09 B	3E-08 B	3E-08 B	2E-07 B	2E-07 B	9E-04 B	7E-04 B	2E-04 B	2E-04 B	2E-03 B	1E-03 B
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**2E-07 B**	**6E-08 B**	**7E-08 B**	**7E-08 B**	**8E-07 B**	**8E-07 B**	**1E-03 B**	**5E-03 B**	**5E-04 B**	**4E-04 B**	**2E-02 B**	**3E-03 B**
Subsurface Soil (1 to 10 ft BLS)	Ingestion	NA	3E-07 B	NA	NA	3E-06 B	3E-06 B	NA	1E+00 B	NA	NA	3E+00 E	3E-01 B
	Dermal Contact	NA	5E-08 B	NA	NA	1E-06 B	1E-06 B	NA	3E-01 B	NA	NA	7E-01 B	5E-01 B
	Inhalation	NA	NA	NA	NA	NA	NA	NA	9E-01	NA	NA	4E+00 E	1E+00 B
	Subtotal	**NA**	**3E-07 B**	**NA**	**NA**	**4E-06 B**	**4E-06 B**	**NA**	**2E+00 E**	**NA**	**NA**	**8E+00 E**	**2E+00 E**
Sediment	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface Water	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Groundwater	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Rabbit	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fish	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface Soil (0 to <1 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								1E-03 B	5E-03 B	5E-04 B	4E-04 B	2E-02 B	3E-03 B
Combined Cancer Risk:		2E-07 B	6E-08 B	7E-08 B	7E-08 B	8E-07 B	8E-07 B						
Subsurface Soil (1 to 10 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	2E+00 E	NA	NA	8E+00 E	2E+00 E
Combined Cancer Risk:		NA	3E-07 B	NA	NA	4E-06 B	4E-06 B						

NA - pathway not evaluated or all detected chemicals eliminated as COPCs
0E+00 - pathway evaluated but no risks could be calculated due to lack of EPA-approved toxicity values
B - HI ≤ 1 or ELCR ≤ 10^{-4}
E - HI > 1 or ELCR > 10^{-4}

Table 6-20. Summary of Receptor Risks and Hazards for COCs at Study Area 07
Reasonable Maximum Exposure
Northern TNT Manufacturing Area, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Soil	Northern TNT Manufacturing Area	2,4,6-Trinitrotoluene	--	--	--	--	2,4,6-Trinitrotoluene	--	--	--	--	--
			2,4-Dinitrotoluene	--	--	--	--	2,4-Dinitrotoluene	--	--	--	--	--
			2,6-Dinitrotoluene	--	--	--	--	2,6-Dinitrotoluene	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
	Air	Northern TNT Manufacturing Area	2,4,6-Trinitrotoluene	--	--	--	--	2,4,6-Trinitrotoluene	--	--	--	--	--
			2,4-Dinitrotoluene	--	--	--	--	2,4-Dinitrotoluene	--	--	--	--	--
			2,6-Dinitrotoluene	--	--	--	--	2,6-Dinitrotoluene	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
Subsurface Soil	Soil	Northern TNT Manufacturing Area	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	1.12	--	0.281	1.40
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			2,4,6-Trinitrotoluene	--	--	--	--	2,4,6-Trinitrotoluene	liver	1.59	--	0.267	1.86
			(Total)	--	--	--	--	(Total)	--	2.71	--	0.548	3.26
	Air	Northern TNT Manufacturing Area	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	--	3.81	--	3.81
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			2,4,6-Trinitrotoluene	--	--	--	--	2,4,6-Trinitrotoluene	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	3.81	--	3.81

Industrial Scenario

For industrial workers exposed to surface soil, the combined cancer risk under RME assumptions is 2×10^{-7}, which falls below the target cancer risk of 1×10^{-4}. The combined RME HI of 0.001 falls below the target HI of 1. Therefore, no COCs were identified for the industrial worker at Study Area 7.

Construction Scenario

For construction workers exposed to soil, the combined cancer risks under RME assumptions are 6×10^{-8} for surface soil exposure and 3×10^{-7} for subsurface soil exposure. The combined RME HIs are 0.005 for surface soil exposure and 2 for subsurface soil exposure. The latter exceeds the target HI of 1. Noncancer effects were segregated according to target organ. The medium TOHIs for subsurface soil do not exceed the target HI. Therefore, no COCs were identified for the construction worker at Study Area 7.

Recreational Scenario

For recreational receptors exposed to surface soil, the combined RME cancer risk for the integrated child or adult receptor is 7×10^{-8}, which is below the target cancer risk of 1×10^{-4}. The combined RME HIs of 5×10^{-4} for the child and 4×10^{-4} for the adult fall below the target HI of 1. Therefore, no COCs were identified for recreational receptors at Study Area 7.

Residential Scenario

The combined RME cancer risks for the integrated child or adult resident are 8×10^{-7} for exposure to surface soil and 4×10^{-6} for exposure to subsurface soil. Both are below the target cancer risk of 1×10^{-4}. For noncancer effects, the combined RME HIs are 0.02 and 8 (surface and subsurface soil exposures, respectively for the child) and 0.003 and 2 (surface and subsurface soil exposures, respectively for the adult). Noncancer effects were segregated according to target organ. For the resident child, the medium TOHIs for the central nervous system and liver exceed the target HI in subsurface soil. The following COCs were identified for residents at Study Area 7 based on noncancer effects:

- manganese: subsurface soil ingestion HQ = 1 (child)
  subsurface soil dermal contact HQ = 0.3 (child)
  subsurface soil inhalation HQ = 4 (child)
- 2,4,6-trinitrotoluene: subsurface soil ingestion HQ = 2 (child)
  subsurface soil dermal contact HQ = 0.3 (child)

6.4.4.7 Study Area 8 – Acid/Organic Manufacturing Area

The pathways evaluated at Study Area 8 are soil ingestion, dermal contact, and inhalation of suspended soil particulates for all receptors and ingestion of rabbit for recreational and resident receptors. The RME risk characterization summary for Study Area 8 is presented in **Table 6-21,** and COCs for each pathway and receptor are listed in **Tables 6-22** through **6-24**.

The maximum detected concentration of lead in soil at Study Area 8 exceeds the 400 ppm screening level in surface and subsurface soils (EPA 1995c). Therefore, models were used to estimate blood lead levels in resident children, industrial workers, and construction workers.

Industrial Scenario

For industrial workers exposed to surface soil, the combined cancer risk under RME assumptions is 8×10^{-5}, which is below the target cancer risk of 1×10^{-4}. The combined RME HI of 2 exceeds the target HI of 1. Noncancer effects were segregated according to target organ. The medium TOHIs for soil do not exceed the target HI. The 95th percentile mean blood lead concentration in the fetus of the industrial worker is 7 µg/dL, which is below the CDC target of 10 µg/dL. Therefore, no COCs were identified for the industrial worker at Study Area 8.

Construction Scenario

For construction workers exposed to soil, the combined cancer risks under RME assumptions are 2×10^{-5} for surface soil exposure and 1×10^{-6} for subsurface soil exposure. Both fall below the target cancer risk of 1×10^{-4}. The combined RME HIs of 6 for surface soil exposure and 3 for subsurface soil exposure exceed the target HI of 1. Noncancer effects were segregated according to target organ. The medium TOHI for the whole body in surface soil exceeds the target HI. In subsurface soil, the medium TOHIs do not exceed the target HI. The 95th percentile mean blood lead concentration in the fetus of the construction worker is 8 µg/dL for surface soil exposure and 9 µg/dL for subsurface soil exposure. Both are below the CDC target of 10 µg/dL. The following COC was identified based on noncancer effects:

- nickel: surface soil ingestion HQ = 3
  surface soil dermal contact HQ = 0.1

Recreational Scenario

For recreational receptors exposed to surface soil, the combined RME (surface soil exposure and rabbit ingestion) cancer risk for the integrated child or adult receptor is 4×10^{-5}, which is below the target cancer risk of 1×10^{-4}. The combined RME HIs of 0.6 for the child and 0.4 for the adult fall below the target HI of 1. Therefore, no COCs were identified for recreational receptors at Study Area 8.

Table 6-21. RME Risk Characterization Summary for Study Area 08 (Current/Future and Future Land Uses)
Acid/Organic Manufacturing Area, Alabama Army Ammunition Plant, Childersburg, Alabama

Medium	Exposure Route	Cancer Risk: Industrial Worker	Cancer Risk: Construction Worker	Cancer Risk: Recreational Child	Cancer Risk: Recreational Adult	Cancer Risk: Residential Child	Cancer Risk: Residential Adult	Noncancer HI: Industrial Worker	Noncancer HI: Construction Worker	Noncancer HI: Recreational Child	Noncancer HI: Recreational Adult	Noncancer HI: Residential Child	Noncancer HI: Residential Adult
Surface Soil (0 to <1 ft BLS)	Ingestion	2E-05 B	2E-05 B	1E-05 B	1E-05 B	2E-04 E	2E-04 E	5E-01 B	5E+00 E	3E-01 B	2E-01 B	1E+01 E	1E+00 B
	Dermal Contact	6E-05 B	5E-06 B	2E-05 B	2E-05 B	1E-04 B	1E-04 B	4E-01 B	4E-01 B	9E-02 B	8E-02 B	9E-01 B	6E-01 B
	Inhalation	8E-07 B	7E-08 B	1E-07 B	1E-07 B	2E-06 B	2E-06 B	7E-01 B	8E-01 B	1E-01 B	6E-02 B	3E+00 E	1E+00 B
	Subtotal	**8E-05 B**	**2E-05 B**	**3E-05 B**	**3E-05 B**	**3E-04 E**	**3E-04 E**	**2E+00 E**	**6E+00 E**	**5E-01 B**	**3E-01 B**	**2E+01 E**	**3E+00 E**
Subsurface Soil (1 to 10 ft BLS)	Ingestion	NA	7E-07 B	NA	NA	8E-06 B	8E-06 B	NA	2E+00 E	NA	NA	5E+00 E	5E-01 B
	Dermal Contact	NA	3E-07 B	NA	NA	6E-06 B	6E-06 B	NA	3E-01 B	NA	NA	7E-01 B	4E-01 B
	Inhalation	NA	5E-08 B	NA	NA	1E-06 B	1E-06 B	NA	5E-01	NA	NA	2E+00 E	6E-01 B
	Subtotal	**NA**	**1E-06 B**	**NA**	**NA**	**2E-05 B**	**2E-05 B**	**NA**	**3E+00 E**	**NA**	**NA**	**8E+00 E**	**2E+00 E**
Sediment	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface Water	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Groundwater	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Rabbit	Ingestion	NA	NA	4E-06 B	4E-06 B	8E-06 B	8E-06 B	NA	NA	4E-02 B	2E-02 B	1E-01 B	5E-02 B
	Subtotal	NA	NA	4E-06 B	4E-06 B	8E-06 B	8E-06 B	NA	NA	4E-02 B	2E-02 B	1E-01 B	5E-02 B
Fish	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface Soil (0 to <1 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								2E+00 E	6E+00 E	6E-01 B	4E-01 B	2E+01 E	3E+00 E
Combined Cancer Risk:		8E-05 B	2E-05 B	4E-05 B	4E-05 B	3E-04 E	3E-04 E						
Subsurface Soil (1 to 10 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	3E+00 E	4E-02 B	2E-02 B	8E+00 E	2E+00 E
Combined Cancer Risk:		NA	1E-06 B	4E-06 B	4E-06 B	2E-05 B	2E-05 B						

NA - pathway not evaluated or all detected chemicals eliminated as COPCs
0E+00 - pathway evaluated but no risks could be calculated due to lack of EPA-approved toxicity values
B - HI $\leq$ 1 or ELCR $\leq 10^{-4}$
E - HI > 1 or ELCR > 10^{-4}

Table 6-22. Summary of Receptor Risks and Hazards for COCs at Study Area 08
Reasonable Maximum Exposure
Acid/Organic Manufacturing Area, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Soil	Acid/Organic Manufacturing Area	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Nickel	--	--	--	--	Nickel	whole body	2.58	--	0.116	2.70
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			Benzo(a)anthracene	--	--	--	--	Benzo(a)anthracene	--	--	--	--	--
			Benzo(a)pyrene	--	--	--	--	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	--	--	--	--	Benzo(b)fluoranthene	--	--	--	--	--
			Dibenzo(a,h)anthracene	--	--	--	--	Dibenzo(a,h)anthracene	--	--	--	--	--
			Indeno(1,2,3-cd)pyrene	--	--	--	--	Indeno(1,2,3-cd)pyrene	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	2.58	--	0.116	2.70
	Air	Acid/Organic Manufacturing Area	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Nickel	--	--	--	--	Nickel	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			Benzo(a)anthracene	--	--	--	--	Benzo(a)anthracene	--	--	--	--	--
			Benzo(a)pyrene	--	--	--	--	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	--	--	--	--	Benzo(b)fluoranthene	--	--	--	--	--
			Dibenzo(a,h)anthracene	--	--	--	--	Dibenzo(a,h)anthracene	--	--	--	--	--
			Indeno(1,2,3-cd)pyrene	--	--	--	--	Indeno(1,2,3-cd)pyrene	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
Subsurface Soil	Soil	Acid/Organic Manufacturing Area	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			Benzo(a)pyrene	--	--	--	--	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	--	--	--	--	Benzo(b)fluoranthene	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
	Air	Acid/Organic Manufacturing Area	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			Benzo(a)pyrene	--	--	--	--	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	--	--	--	--	Benzo(b)fluoranthene	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--

Table 6-23. Summary of Receptor Risks and Hazards for COCs at Study Area 08
Reasonable Maximum Exposure
Acid/Organic Manufacturing Area, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Soil	Acid/Organic Manufacturing Area	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	5.841E-05	--	3.481E-06	6.189E-05	Arsenic	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	3.34	--	0.224	3.56
			Manganese	--	--	--	--	Manganese	CNS	0.986	--	0.248	1.23
			Nickel	--	--	--	--	Nickel	whole body	7.03	--	0.262	7.29
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			Benzo(a)anthracene	1.820E-05	--	1.435E-05	3.255E-05	Benzo(a)anthracene	--	--	--	--	--
			Benzo(a)pyrene	0.000102	--	8.036E-05	0.000182	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	8.849E-06	--	6.975E-06	1.582E-05	Benzo(b)fluoranthene	--	--	--	--	--
			Dibenzo(a,h)anthracene	8.432E-06	--	6.646E-06	1.508E-05	Dibenzo(a,h)anthracene	--	--	--	--	--
			Indeno(1,2,3-cd)pyrene	4.826E-06	--	3.804E-06	8.630E-06	Indeno(1,2,3-cd)pyrene	--	--	--	--	--
			(Total)	0.000201	--	0.000116	0.000316	(Total)	--	11	--	0.733	12
	Air	Acid/Organic Manufacturing Area	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	1.780E-06	--	1.780E-06	Arsenic	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	--	3.35	--	3.35
			Nickel	--	--	--	--	Nickel	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			Benzo(a)anthracene	--	--	--	--	Benzo(a)anthracene	--	--	--	--	--
			Benzo(a)pyrene	--	--	--	--	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	--	--	--	--	Benzo(b)fluoranthene	--	--	--	--	--
			Dibenzo(a,h)anthracene	--	--	--	--	Dibenzo(a,h)anthracene	--	--	--	--	--
			Indeno(1,2,3-cd)pyrene	--	--	--	--	Indeno(1,2,3-cd)pyrene	--	--	--	--	--
			(Total)	--	1.780E-06	--	1.780E-06	(Total)	--	--	3.35	--	3.35
Subsurface Soil	Soil	Acid/Organic Manufacturing Area	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	3.68	--	0.247	3.93
			Manganese	--	--	--	--	Manganese	CNS	0.625	--	0.157	0.782
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			Benzo(a)pyrene	--	--	--	--	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	--	--	--	--	Benzo(b)fluoranthene	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	4.31	--	0.404	4.71
	Air	Acid/Organic Manufacturing Area	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	--	2.13	--	2.13
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			Benzo(a)pyrene	--	--	--	--	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	--	--	--	--	Benzo(b)fluoranthene	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	2.13	--	2.13
Rabbit	Tissue	Acid/Organic Manufacturing Area	Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Nickel	--	--	--	--	Nickel	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--

Table 6-24. Summary of Receptor Risks and Hazards for COCs at Study Area 08
Reasonable Maximum Exposure
Acid/Organic Manufacturing Area, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Soil	Acid/Organic Manufacturing Area	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	5.841E-05	--	3.481E-06	6.189E-05	Arsenic	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Nickel	--	--	--	--	Nickel	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			Benzo(a)anthracene	1.820E-05	--	1.435E-05	3.255E-05	Benzo(a)anthracene	--	--	--	--	--
			Benzo(a)pyrene	0.000102	--	8.036E-05	0.000182	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	8.849E-06	--	6.975E-06	1.582E-05	Benzo(b)fluoranthene	--	--	--	--	--
			Dibenzo(a,h)anthracene	8.432E-06	--	6.646E-06	1.508E-05	Dibenzo(a,h)anthracene	--	--	--	--	--
			Indeno(1,2,3-cd)pyrene	4.826E-06	--	3.804E-06	8.630E-06	Indeno(1,2,3-cd)pyrene	--	--	--	--	--
			(Total)	0.000201	--	0.000116	0.000316	(Total)	--	--	--	--	--
	Air	Acid/Organic Manufacturing Area	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	1.780E-06	--	1.780E-06	Arsenic	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Nickel	--	--	--	--	Nickel	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			Benzo(a)anthracene	--	--	--	--	Benzo(a)anthracene	--	--	--	--	--
			Benzo(a)pyrene	--	--	--	--	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	--	--	--	--	Benzo(b)fluoranthene	--	--	--	--	--
			Dibenzo(a,h)anthracene	--	--	--	--	Dibenzo(a,h)anthracene	--	--	--	--	--
			Indeno(1,2,3-cd)pyrene	--	--	--	--	Indeno(1,2,3-cd)pyrene	--	--	--	--	--
			(Total)	--	1.780E-06	--	1.780E-06	(Total)	--	--	--	--	--
Subsurface Soil	Soil	Acid/Organic Manufacturing Area	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			Benzo(a)pyrene	--	--	--	--	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	--	--	--	--	Benzo(b)fluoranthene	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
	Air	Acid/Organic Manufacturing Area	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			Benzo(a)pyrene	--	--	--	--	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	--	--	--	--	Benzo(b)fluoranthene	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
Rabbit	Tissue	Acid/Organic Manufacturing Area	Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Nickel	--	--	--	--	Nickel	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--

Residential Scenario

The combined RME cancer risks for the integrated child or adult resident are 3×10^{-4} for exposure to surface soil and ingestion of rabbit, which are above the target cancer risk of 1×10^{-4}, and 2×10^{-5} for exposure to subsurface soil and ingestion of rabbit. For noncancer effects, the combined RME HIs are 20 (surface soil exposure and rabbit ingestion for the child) and 8 (subsurface soil exposure and rabbit ingestion for the child). For the adult, the combined RME HIs are 3 (surface soil exposure and rabbit ingestion) and 2 (subsurface soil exposure and rabbit ingestion). Noncancer effects were segregated according to target organ. In surface soil, the medium TOHIs for the central nervous system and whole body exceed the target HI for the child. In subsurface soil, the medium TOHI for the central nervous system exceeds the target HI for the child. The 95th percentile mean blood lead concentration in the resident child is 9 µg/dL for surface soil exposure and 11 µg/dL for subsurface soil exposure. The latter is above the CDC target of 10 µg/dL. The following COCs were identified for residents at Study Area 8 based on cancer and noncancer effects:

- arsenic: surface soil ingestion cancer risk = 6×10^{-5}
  surface soil dermal contact cancer risk = 3×10^{-6}
  surface soil inhalation cancer risk = 2×10^{-6}
- iron: surface soil ingestion HQ = 3 (child)
  surface soil dermal contact HQ = 0.2 (child)
  subsurface soil ingestion HQ = 4 (child)
  subsurface soil dermal contact HQ = 0.2 (child)
- lead: subsurface soil, 95th percentile mean blood lead level = 11 µg/dL
- manganese: surface soil ingestion HQ = 1 (child)
  surface soil dermal contact HQ = 0.2 (child)
  surface soil inhalation HQ = 3 (child)
  subsurface soil ingestion HQ = 0.6 (child)
  subsurface soil dermal contact HQ = 0.2 (child)
  subsurface soil inhalation HQ = 2 (child)
- nickel: surface soil ingestion HQ = 7 (child)
  surface soil dermal contact HQ = 0.3 (child)
- benzo(a)anthracene: surface soil ingestion cancer risk = 2×10^{-5}
  surface soil dermal contact cancer risk = 1×10^{-5}
- benzo(a)pyrene: surface soil ingestion cancer risk = 1×10^{-4}
  surface soil dermal contact cancer risk = 8×10^{-5}

- benzo(b)fluoranthene: surface soil ingestion cancer risk = 9×10^{-6}
  surface soil dermal contact cancer risk = 7×10^{-6}
- dibenzo(a,h)anthracene: surface soil ingestion cancer risk = 8×10^{-6}
  surface soil dermal contact cancer risk = 7×10^{-6}
- indeno(1,2,3-cd)pyrene: surface soil ingestion cancer risk = 5×10^{-6}
  surface soil dermal contact cancer risk = 4×10^{-6}

6.4.4.8 Study Area 8 – Test Pits

The pathways evaluated for the Study Area 8 test pits are soil ingestion, dermal contact, and inhalation of suspended soil particulates. The RME risk characterization summary for the Study Area 8 test pits is presented in **Table 6-25**, and COCs for each pathway and receptor are listed in **Tables 6-26** through **6-28**.

Industrial Scenario

Industrial workers were assumed to be exposed only to surface soils. Risks were not calculated for industrial workers because surface soil samples were not collected from the test pits.

Construction Scenario

For construction workers exposed to subsurface soil, the combined cancer risk under RME assumptions is 1×10^{-5}, which is below the target cancer risk of 1×10^{-4}. The combined RME HI of 8 exceeds the target HI of 1. Noncancer effects were segregated according to target organ. Only one COC was identified for the construction worker at the test pits:

- iron: subsurface soil ingestion HQ = 5
  subsurface soil dermal contact HQ = 0.4

Recreational Scenario

Recreational receptors were assumed to be exposed only to surface soils. Risks were not calculated for recreational receptors because surface soil samples were not collected from the test pits.

Residential Scenario

The combined RME cancer risk for the integrated child or adult resident is 1×10^{-4} for exposure to subsurface soil. This equals but does not exceed the target cancer risk of 1×10^{-4}. For noncancer effects, the combined RME HIs of 20 for the child and 3 for the adult are above the target

Table 6-25. RME Risk Characterization Summary for Study Area 08 - Test Pits (Current/Future and Future Land Uses)
Acid/Organic Manufacturing Area, Alabama Army Ammunition Plant, Childersburg, Alabama

Medium	Exposure Route	Cancer Risk						Noncancer HI					
		Industrial Worker	Construction Worker	Recreational Child	Recreational Adult	Residential Child	Residential Adult	Industrial Worker	Construction Worker	Recreational Child	Recreational Adult	Residential Child	Residential Adult
Surface Soil (0 to < 1 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Subsurface Soil (1 to 10 ft BLS)	Ingestion	NA	1E-05 B	NA	NA	1E-04 B	1E-04 B	NA	7E+00 E	NA	NA	2E+01 E	2E+00 E
	Dermal Contact	NA	3E-07 B	NA	NA	7E-06 B	7E-06 B	NA	1E+00 B	NA	NA	2E+00 E	1E+00 B
	Inhalation	NA	2E-07 B	NA	NA	5E-06 B	5E-06 B	NA	1E-03	NA	NA	5E-03 B	2E-03 B
	Subtotal	NA	1E-05 B	NA	NA	1E-04 B	1E-04 B	NA	8E+00 E	NA	NA	2E+01 E	3E+00 E
Sediment	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface Water	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Groundwater	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Rabbit	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fish	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface Soil (0 to < 1 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	NA	NA	NA	NA	NA
Combined Cancer Risk:		NA	NA	NA	NA	NA	NA						
Subsurface Soil (1 to 10 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	8E+00 E	NA	NA	2E+01 E	3E+00 E
Combined Cancer Risk:		NA	1E-05 B	NA	NA	1E-04 B	1E-04 B						

NA - pathway not evaluated or all detected chemicals eliminated as COPCs
0E+00 - pathway evaluated but no risks could be calculated due to lack of EPA-approved toxicity values
B - HI $\leq$ 1 or ELCR $\leq 10^{-4}$
E - HI > 1 or ELCR > 10^{-4}

Table 6-26. Summary of Receptor Risks and Hazards for COCs at Study Area 08 - Test Pits
Reasonable Maximum Exposure
Acid/Organic Manufacturing Area, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Subsurface Soil	Soil	Acid/Organic Manufacturing Area	Antimony	--	--	--	--	Antimony	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	5.01	--	0.404	5.41
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	5.01	--	0.40	5.41
	Air	Acid/Organic Manufacturing Area	Antimony	--	--	--	--	Antimony	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--

Table 6-27. Summary of Receptor Risks and Hazards for COCs at Study Area 08 - Test Pits
Reasonable Maximum Exposure
Acid/Organic Manufacturing Area, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Subsurface Soil	Soil	Acid/Organic Manufacturing Area	Antimony	--	--	--	--	Antimony	whole body, blood	2.22	--	1.12	3.34
			Arsenic	--	--	--	--	Arsenic	skin	2.16	--	0.0529	2.21
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	14	--	0.914	15
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	18	--	2.08	20
	Air	Acid/Organic Manufacturing Area	Antimony	--	--	--	--	Antimony	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--

Table 6-28. Summary of Receptor Risks and Hazards for COCs at Study Area 08 - Test Pits
Reasonable Maximum Exposure
Acid/Organic Manufacturing Area, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Subsurface Soil	Soil	Acid/Organic Manufacturing Area	Antimony	--	--	--	--	Antimony	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	1.46	--	0.565	2.03
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	1.46	--	0.56	2.03
	Air	Acid/Organic Manufacturing Area	Antimony	--	--	--	--	Antimony	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--

HI of 1. Noncancer effects were segregated according to target organ. For the resident child, the medium TOHIs for the skin, whole body, and blood exceed the target HI. The following COCs were identified for residents at the Study Area 8 test pits based on noncancer effects:

- antimony: subsurface soil ingestion HQ = 2 (child)
  subsurface soil dermal contact HQ = 1 (child)
- arsenic: subsurface soil ingestion HQ = 2 (child)
- iron: subsurface soil ingestion HQ = 14 (child), 1 (adult)
  subsurface soil dermal contact HQ = 0.9 (child), 0.6 (adult)

6.4.4.9 Study Area 9 – Aniline Sludge Basin

The pathways evaluated at Study Area 9 are sediment and surface water ingestion and dermal contact for recreational and residential receptors. The RME risk characterization summary for Study Area 9 is presented in **Table 6-29**, and COCs are listed in **Table 6-30**.

Recreational Scenario

The combined RME cancer risk for the integrated child or adult receptor is 2×10^{-5}, which is below the target cancer risk of 1×10^{-4}. Cancer risks were not quantified for surface water because none of the COPCs has a toxicity value for cancer effects. The combined RME HIs of 0.4 for the child and 0.3 for the adult fall below the target HI of 1. Therefore, no COCs were identified for recreational receptors at the Aniline Sludge Basin.

Residential Scenario

The combined RME cancer risk for the integrated child or adult resident exposed to sediment is 5×10^{-5}. This is below the target cancer risk of 1×10^{-4}. Cancer risks were not quantified for surface water because none of the COPCs has a toxicity value for cancer effects. For noncancer effects, the combined RME HIs are 4 for the child and 0.5 for the adult. The former exceeds the target HI of 1 due to exposure to sediment. Noncancer effects were segregated according to target organ. Only one COC was identified for the resident child:

- iron: sediment ingestion HQ = 2 (child)
  sediment dermal contact HQ = 0.2 (child)

6.4.4.10 Study Area 9 – Tar and Sediment Beneath the Tar

An additional evaluation conducted at Study Area 9 involved sampling sediment from an isolated area containing a tar-like substance. Samples were collected from the tar and sediment

Table 6-29. RME Risk Characterization Summary for Study Area 09 (Current/Future and Future Land Uses) Aniline Sludge Basin, Alabama Army Ammunition Plant, Childersburg, Alabama

Medium	Exposure Route	Cancer Risk						Noncancer HI					
		Industrial Worker	Construction Worker	Recreational Child	Recreational Adult	Residential Child	Residential Adult	Industrial Worker	Construction Worker	Recreational Child	Recreational Adult	Residential Child	Residential Adult
Surface Soil (0 to <1 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Subsurface Soil (1 to 10 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sediment	Ingestion	NA	NA	1E-05 B	1E-05 B	5E-05 B	5E-05 B	NA	NA	3E-01 B	2E-01 B	3E+00 E	4E-01 B
	Dermal Contact	NA	NA	2E-06 B	2E-06 B	4E-06 B	4E-06 B	NA	NA	9E-02 B	8E-02 B	2E-01 B	2E-01 B
	Subtotal	NA	NA	2E-05 B	2E-05 B	5E-05 B	5E-05 B	NA	NA	4E-01 B	3E-01 B	4E+00 E	5E-01 B
Surface Water	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	4E-04 B	5E-05 B	2E-03 B	1E-04 B
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	2E-04 B	2E-04 B	6E-04 B	4E-04 B
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	6E-04 B	3E-04 B	3E-03 B	5E-04 B
Groundwater	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Rabbit	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fish	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface Soil (0 to <1 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	NA	4E-01 B	3E-01 B	4E+00 E	5E-01 B
Combined Cancer Risk:		NA	NA	2E-05 B	2E-05 B	5E-05 B	5E-05 B						
Subsurface Soil (1 to 10 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	NA	4E-01 B	3E-01 B	4E+00 E	5E-01 B
Combined Cancer Risk:		NA	NA	2E-05 B	2E-05 B	5E-05 B	5E-05 B						

NA - pathway not evaluated or all detected chemicals eliminated as COPCs
0E+00 - pathway evaluated but no risks could be calculated due to lack of EPA-approved toxicity values
B - HI $\leq$ 1 or ELCR $\leq 10^{-4}$
E - HI > 1 or ELCR > 10^{-4}

Table 6-30. Summary of Receptor Risks and Hazards for COCs at Study Area 09
Reasonable Maximum Exposure
Aniline Sludge Basin, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water	Surface Water	Aniline Sludge Basin	Copper	--	--	--	--	Copper	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
Sediment	Sediment	Aniline Sludge Basin	Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Copper	--	--	--	--	Copper	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	2.25	--	0.151	2.40
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			4-Amino-2,6-Dinitrotoluene	--	--	--	--	4-Amino-2,6-Dinitrotoluene	--	--	--	--	--
			Benzo(a)pyrene	--	--	--	--	Benzo(a)pyrene	--	--	--	--	--
			N-Nitrosodiphenylamine	--	--	--	--	N-Nitrosodiphenylamine	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	2.25	--	0.151	2.40

beneath the tar. The pathways evaluated are ingestion and dermal contact for recreational and residential receptors. The RME risk characterization summary for the Study Area 9 tar is presented in **Table 6-31**, and COCs for the tar are listed in **Tables 6-32** through **6-35**. The RME risk characterization summary and associated tables for the sediment beneath the tar are included in Appendix N.

The maximum detected concentration of lead in the Study Area 9 tar exceeds the 400 ppm screening level (EPA 1995c). Therefore, the EPA biokinetic uptake model was used to estimate blood lead levels in resident children. In using this model, the tar is treated as if it were soil.

Recreational Scenario

The combined RME cancer risk for the integrated child or adult receptor exposed to the tar is 3×10^{-3}, which exceeds the target cancer risk of 1×10^{-4}. The combined RME HIs of 0.4 for the child and 0.3 for the adult fall below the target HI of 1. The following COCs were identified for the integrated child or adult recreational receptor exposed to the tar based on cancer effects:

- N-Nitrosodiphenylamine: tar ingestion cancer risk = 1×10^{-3}
  tar dermal contact cancer risk = 2×10^{-3}

Risks calculated for the integrated child or adult receptor exposed to the sediment beneath the tar do not exceed the target cancer risk of 1×10^{-4} or the target HI of 1 (see Appendix N). Therefore, no COCs were identified in the sediment beneath the tar.

Residential Scenario

The combined RME cancer risk for the integrated child or adult resident exposed to the tar is 8×10^{-3}, which exceeds the target cancer risk of 1×10^{-4}. The combined RME HIs are 3 for the child and 0.5 for the adult. The former exceeds the target HI of 1. Noncancer effects were segregated according to target organ. The 95th percentile mean blood lead concentration in the resident child exposed to the tar is 26 µg/dL, which is above the CDC target of 10 µg/dL. The following COCs were identified for the integrated child or adult recreational receptor exposed to the tar based on cancer and noncancer effects:

- iron: tar ingestion HQ = 3 (child)
  tar dermal contact HQ = 0.2 (child)
- lead: tar, 95th percentile mean blood lead level = 26 µg/dL
- N-Nitrosodiphenylamine: tar ingestion cancer risk = 4×10^{-3}
  tar dermal contact cancer risk = 4×10^{-3}

Table 6-31. RME Risk Characterization Summary for Study Area 09 - Tar (Current/Future and Future Land Uses)
Aniline Sludge Basin, Alabama Army Ammunition Plant, Childersburg, Alabama

Medium	Exposure Route	Cancer Risk						Noncancer HI					
		Industrial Worker	Construction Worker	Recreational Child	Recreational Adult	Residential Child	Residential Adult	Industrial Worker	Construction Worker	Recreational Child	Recreational Adult	Residential Child	Residential Adult
Surface Soil (0 to < 1 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Subsurface Soil (1 to 10 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sediment	Ingestion	NA	NA	1E-03 E	1E-03 E	4E-03 E	4E-03 E	NA	NA	3E-01 B	2E-01 B	3E+00 E	3E-01 B
	Dermal Contact	NA	NA	2E-03 E	2E-03 E	4E-03 E	4E-03 E	NA	NA	9E-02 B	8E-02 B	2E-01 B	1E-01 B
	Subtotal	NA	NA	3E-03 E	3E-03 E	8E-03 E	8E-03 E	NA	NA	4E-01 B	3E-01 B	3E+00 E	5E-01 B
Surface Water	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Groundwater	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Rabbit	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fish	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface Soil (0 to <1 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	NA	4E-01 B	3E-01 B	3E+00 E	5E-01 B
Combined Cancer Risk:		NA	NA	3E-03 E	3E-03 E	8E-03 E	8E-03 E						
Subsurface Soil (1 to 10 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	NA	4E-01 B	3E-01 B	3E+00 E	5E-01 B
Combined Cancer Risk:		NA	NA	3E-03 E	3E-03 E	8E-03 E	8E-03 E						

NA - pathway not evaluated or all detected chemicals eliminated as COPCs
0E+00 - pathway evaluated but no risks could be calculated due to lack of EPA-approved toxicity values
B - HI $\leq$ 1 or ELCR $\leq 10^{-4}$
E - HI > 1 or ELCR > 10^{-4}

Table 6-32. Summary of Receptor Risks and Hazards for COCs at Study Area 09 - Tar
Reasonable Maximum Exposure
Aniline Sludge Basin, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Recreational User
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment	Sediment	Aniline Sludge Basin	Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Copper	--	--	--	--	Copper	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Nickel	--	--	--	--	Nickel	--	--	--	--	--
			N-Nitrosodiphenylamine	0.00108	--	0.00222	0.00331	N-Nitrosodiphenylamine	--	--	--	--	--
			(Total)	0.00108	--	0.00222	0.00331	(Total)	--	--	--	--	--

Table 6-33. Summary of Receptor Risks and Hazards for COCs at Study Area 09 - Tar
Reasonable Maximum Exposure
Aniline Sludge Basin, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Recreational User
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment	Sediment	Aniline Sludge Basin	Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Copper	--	--	--	--	Copper	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Nickel	--	--	--	--	Nickel	--	--	--	--	--
			N-Nitrosodiphenylamine	0.00108	--	0.00222	0.00331	N-Nitrosodiphenylamine	--	--	--	--	--
			(Total)	0.00108	--	0.00222	0.00331	(Total)	--	--	--	--	--

Table 6-34. Summary of Receptor Risks and Hazards for COCs at Study Area 09 - Tar
Reasonable Maximum Exposure
Aniline Sludge Basin, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment	Sediment	Aniline Sludge Basin	Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Copper	--	--	--	--	Copper	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	2.58	--	0.173	2.75
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Nickel	--	--	--	--	Nickel	--	--	--	--	--
			N-Nitrosodiphenylamine	0.00395	--	0.00386	0.00780	N-Nitrosodiphenylamine	--	--	--	--	--
			(Total)	0.00395	--	0.00386	0.00780	(Total)	--	2.58	--	0.173	2.75

Table 6-35. Summary of Receptor Risks and Hazards for COCs at Study Area 09 - Tar
Reasonable Maximum Exposure
Aniline Sludge Basin, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment	Sediment	Aniline Sludge Basin	Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Copper	--	--	--	--	Copper	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Nickel	--	--	--	--	Nickel	--	--	--	--	--
			N-Nitrosodiphenylamine	0.00395	--	0.00386	0.00780	N-Nitrosodiphenylamine	--	--	--	--	--
			(Total)	0.00395	--	0.00386	0.00780	(Total)	--	--	--	--	--

Risks calculated for the integrated child or adult resident exposed to the sediment beneath the tar do not exceed the target cancer risk of 1×10^{-4} or the target HI of 1 (see Appendix N). Therefore, no COCs were identified in the sediment beneath the tar.

Subsequent to the RI, the tar from the Aniline Sludge Basin was excavated. The excavation was conducted by Environmental Chemical Corporation (ECC) in February 1999. The total amount of material excavated was 3,063 cubic yards. After the tar was excavated, confirmatory samples were collected and analyzed for metals and SVOCs. The samples showed no exceedances of the Alabama Department of Environmental Management's (ADEM's) Toxicity Characteristics Leaching Procedure (TCLP) regulatory limit. The excavation area was then backfilled, compacted, and seeded. (ECC 1999).

6.4.4.11 Study Area 10 – Tetryl Manufacturing Area (East)

The pathways evaluated at Study Area 10–East are soil ingestion, dermal contact, and inhalation of suspended soil particulates for all receptors and ingestion of rabbit for recreational and resident receptors. The RME risk characterization summary for Study Area 10–East is presented in **Table 6-36**, and COCs for each pathway and receptor are listed in **Tables 6-37** through **6-40**.

Industrial Scenario

For industrial workers exposed to surface soil, the combined cancer risk under RME assumptions is 7×10^{-6}, which is below the target cancer risk of 1×10^{-4}. The combined RME HI of 2 exceeds the target HI of 1. Noncancer effects were segregated according to target organ. The medium TOHI for the central nervous system exceeds the target HI. Therefore, the following COC was identified for the industrial worker based on noncancer effects:

- manganese: surface soil dermal contact HQ = 0.2
  surface soil inhalation HQ = 2

Construction Scenario

For construction workers exposed to soil, the combined cancer risks under RME assumptions are 4×10^{-6} for surface soil exposure and 9×10^{-8} for subsurface soil exposure. Both fall below the target cancer risk of 1×10^{-4}. The combined RME HIs of 4 for surface soil exposure and 2 for subsurface soil exposure exceed the target HI of 1. Noncancer effects were segregated according to target organ. The medium TOHI for the central nervous system in surface soil exceeds the target HI. In subsurface soil, the medium TOHIs do not exceed the target HI. The following COC was identified based on noncancer effects:

- manganese: surface soil ingestion HQ = 0.8
  surface soil dermal contact HQ = 0.2
  surface soil inhalation HQ = 2

Table 6-36. RME Risk Characterization Summary for Study Area 10E (Current/Future and Future Land Use) Tetryl Manufacturing Area-East, Alabama Army Ammunition Plant, Childersburg, Alabama

Medium	Exposure Route	Cancer Risk: Industrial Worker	Cancer Risk: Construction Worker	Cancer Risk: Recreational Child	Cancer Risk: Recreational Adult	Cancer Risk: Residential Child	Cancer Risk: Residential Adult	Noncancer HI: Industrial Worker	Noncancer HI: Construction Worker	Noncancer HI: Recreational Child	Noncancer HI: Recreational Adult	Noncancer HI: Residential Child	Noncancer HI: Residential Adult
Surface Soil (0 to <1 ft BLS)	Ingestion	5E-06 B	4E-06 B	3E-06 B	3E-06 B	4E-05 B	4E-05 B	2E-01 B	2E+00 E	1E-01 B	7E-02 B	5E+00 E	5E-01 B
	Dermal Contact	1E-06 B	1E-07 B	4E-07 B	4E-07 B	3E-06 B	3E-06 B	3E-01 B	3E-01 B	7E-02 B	6E-02 B	7E-01 B	4E-01 B
	Inhalation	5E-07 B	5E-08 B	9E-08 B	9E-08 B	1E-06 B	1E-06 B	2E+00 E	2E+00 E	3E-01 B	1E-01 B	7E+00 E	2E+00 E
	Subtotal	**7E-06 B**	**4E-06 B**	**4E-06 B**	**4E-06 B**	**5E-05 B**	**5E-05 B**	**2E+00 E**	**4E+00 E**	**5E-01 B**	**3E-01 B**	**1E+01 E**	**3E+00 E**
Subsurface Soil (1 to 10 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	NA	1E+00 B	NA	NA	3E+00 E	3E-01 B
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	2E-01 B	NA	NA	5E-01 B	3E-01 B
	Inhalation	NA	9E-08 B	NA	NA	2E-06 B	2E-06 B	NA	4E-01	NA	NA	2E+00 E	5E-01 B
	Subtotal	**NA**	**9E-08 B**	**NA**	**NA**	**2E-06 B**	**2E-06 B**	**NA**	**2E+00 E**	**NA**	**NA**	**5E+00 E**	**1E+00 B**
Sediment	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Surface Water	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Groundwater	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Rabbit	Ingestion	NA	NA	4E-06 B	4E-06 B	8E-06 B	8E-06 B	NA	NA	3E-02 B	2E-02 B	8E-02 B	3E-02 B
	Subtotal	**NA**	**NA**	**4E-06 B**	**4E-06 B**	**8E-06 B**	**8E-06 B**	**NA**	**NA**	**3E-02 B**	**2E-02 B**	**8E-02 B**	**3E-02 B**
Fish	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Surface Soil (0 to <1 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								2E+00 E	4E+00 E	5E-01 B	3E-01 B	1E+01 E	3E+00 E
Combined Cancer Risk:		7E-06 B	4E-06 B	8E-06 B	8E-06 B	6E-05 B	6E-05 B						
Subsurface Soil (1 to 10 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	2E+00 E	3E-02 B	2E-02 B	5E+00 E	1E+00 B
Combined Cancer Risk:		NA	9E-08 B	4E-06 B	4E-06 B	1E-05 B	1E-05 B						

NA - pathway not evaluated or all detected chemicals eliminated as COPCs
0E+00 - pathway evaluated but no risks could be calculated due to lack of EPA-approved toxicity values
B - HI $\leq$ 1 or ELCR $\leq 10^{-4}$
E - HI > 1 or ELCR > 10^{-4}

Table 6-37. Summary of Receptor Risks and Hazards for COCs at Study Area 10E
Reasonable Maximum Exposure
Tetryl Manufacturing Area-East, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Current/Future
Receptor Population: Industrial Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Soil	Tetryl Manufacturing Area-East	Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
	Air	Tetryl Manufacturing Area-East	Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	--	1.52	--	1.52
			(Total)	--	--	--	--	(Total)	--	--	1.52	--	1.52

Table 6-38. Summary of Receptor Risks and Hazards for COCs at Study Area 10E
Reasonable Maximum Exposure
Tetryl Manufacturing Area-East, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Soil	Tetryl Manufacturing Area-East	Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	0.802	--	0.242	1.04
			(Total)	--	--	--	--	(Total)	--	0.80	--	0.242	1.04
	Air	Tetryl Manufacturing Area-East	Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	--	1.82	--	1.82
			(Total)	--	--	--	--	(Total)	--	--	1.82	--	1.82
Subsurface Soil	Soil	Tetryl Manufacturing Area-East	Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
	Air	Tetryl Manufacturing Area-East	Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--

Table 6-39. Summary of Receptor Risks and Hazards for COCs at Study Area 10E
Reasonable Maximum Exposure
Tetryl Manufacturing Area-East, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Soil	Tetryl Manufacturing Area-East	Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	1.62	--	0.109	1.73
			Manganese	--	--	--	--	Manganese	CNS	2.18	--	0.549	2.73
			(Total)	--	--	--	--	(Total)	--	3.80	--	0.657	4.46
	Air	Tetryl Manufacturing Area-East	Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	--	7.43	--	7.43
			(Total)	--	--	--	--	(Total)	--	--	7.43	--	7.43
Subsurface Soil	Soil	Tetryl Manufacturing Area-East	Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	2.24	--	0.150	2.39
			Manganese	--	--	--	--	Manganese	CNS	0.478	--	0.120	0.598
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	2.72	--	0.270	2.99
	Air	Tetryl Manufacturing Area-East	Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	--	1.63	--	1.63
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	1.63	--	1.63
Rabbit	Tissue	Tetryl Manufacturing Area-East	Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--

Table 6-40. Summary of Receptor Risks and Hazards for COCs at Study Area 10E
Reasonable Maximum Exposure
Tetryl Manufacturing Area-East, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Soil	Tetryl Manufacturing Area-East	Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	0.234	--	0.339	0.573
			(Total)	--	--	--	--	(Total)	--	0.234	--	0.339	0.573
	Air	Tetryl Manufacturing Area-East	Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	--	2.12	--	2.12
			(Total)	--	--	--	--	(Total)	--	--	2.12	--	2.12
Subsurface Soil	Soil	Tetryl Manufacturing Area-East	Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
	Air	Tetryl Manufacturing Area-East	Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
Rabbit	Tissue	Tetryl Manufacturing Area-East	Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--

Recreational Scenario

For recreational receptors exposed to surface soil, the combined RME cancer risk for the integrated child or adult receptor is 4×10^{-6}, which is below the target cancer risk of 1×10^{-4}. The combined RME HIs of 0.5 for the child and 0.3 for the adult fall below the target HI of 1. Therefore, no COCs were identified for recreational receptors at Study Area 10–East.

Residential Scenario

The combined RME cancer risks for the integrated child or adult resident are 6×10^{-5} for exposure to surface soil and ingestion of rabbit and 1×10^{-5} for exposure to subsurface soil and ingestion of rabbit. For noncancer effects, the combined RME HIs are 10 (surface soil exposure and rabbit ingestion for the child) and 5 (subsurface soil exposure and rabbit ingestion for the child). For the adult, the combined RME HIs are 3 (surface soil exposure and rabbit ingestion) and 1 (subsurface soil exposure and rabbit ingestion). Noncancer effects were segregated according to target organ. In surface and subsurface soils, the medium TOHI for the central nervous system exceeds the target HI for the child and the adult. The following COCs were identified for residents at Study Area 10–East based on noncancer effects:

- iron:
  - surface soil ingestion HQ = 2 (child)
  - surface soil dermal contact HQ = 0.1 (child)
  - subsurface soil ingestion HQ = 2 (child)
  - subsurface soil dermal contact HQ = 0.2 (child)
- manganese:
  - surface soil ingestion HQ = 2 (child), 0.2 (adult)
  - surface soil dermal contact HQ = 0.5 (child), 0.3 (adult)
  - surface soil inhalation HQ = 7 (child), 2 (adult)
  - subsurface soil ingestion HQ = 0.5 (child)
  - subsurface soil dermal contact HQ = 0.1 (child)
  - subsurface soil inhalation HQ = 2 (child)

6.4.4.12 Study Area 10 – Tetryl Manufacturing Area (West)

The pathways evaluated at Study Area 10–West are soil ingestion, dermal contact, and inhalation of suspended soil particulates for all receptors. The RME risk characterization summary for Study Area 10–West is presented in **Table 6-41**.

The maximum detected concentration of lead at Study Area 10—West exceeds the 400 ppm screening level in surface soil (EPA 1995c). Therefore, models were used to estimate blood lead levels in resident children, industrial workers, and construction workers.

Table 6-41. RME Risk Characterization Summary for Study Area 10W (Current/Future and Future Land Use) Tetryl Manufacturing Area-West, Alabama Army Ammunition Plant, Childersburg, Alabama

Medium	Exposure Route	Cancer Risk: Industrial Worker	Cancer Risk: Construction Worker	Cancer Risk: Recreational Child	Cancer Risk: Recreational Adult	Cancer Risk: Residential Child	Cancer Risk: Residential Adult	Noncancer HI: Industrial Worker	Noncancer HI: Construction Worker	Noncancer HI: Recreational Child	Noncancer HI: Recreational Adult	Noncancer HI: Residential Child	Noncancer HI: Residential Adult
Surface Soil (0 to <1 ft BLS)	Ingestion	3E-08 B	2E-08 B	2E-08 B	2E-08 B	3E-07 B	3E-07 B	1E-04 B	7E-04 B	7E-05 B	4E-05 B	3E-03 B	3E-04 B
	Dermal Contact	7E-08 B	6E-09 B	2E-08 B	2E-08 B	1E-07 B	1E-07 B	3E-04 B	2E-04 B	6E-05 B	5E-05 B	6E-04 B	4E-04 B
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**1E-07 B**	**3E-08 B**	**4E-08 B**	**4E-08 B**	**4E-07 B**	**4E-07 B**	**4E-04 B**	**8E-04 B**	**1E-04 B**	**9E-05 B**	**3E-03 B**	**7E-04 B**
Subsurface Soil (1 to 10 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	NA	9E-03 B	NA	NA	2E-01 B	3E-02 B
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	2E-03 B	NA	NA	5E-02 B	3E-02 B
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**1E-02 B**	**NA**	**NA**	**3E-01 B**	**6E-02 B**
Sediment	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Surface Water	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Groundwater	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Rabbit	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Fish	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Surface Soil (0 to <1 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								4E-04 B	8E-04 B	1E-04 B	9E-05 B	3E-03 B	7E-04 B
Combined Cancer Risk:		1E-07 B	3E-08 B	4E-08 B	4E-08 B	4E-07 B	4E-07 B						
Subsurface Soil (1 to 10 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	1E-02 B	NA	NA	3E-01 B	6E-02 B
Combined Cancer Risk:		NA	NA	NA	NA	NA	NA						

NA - pathway not evaluated or all detected chemicals eliminated as COPCs
0E+00 - pathway evaluated but no risks could be calculated due to lack of EPA-approved toxicity values
B - HI ≤ 1 or ELCR ≤ 10^{-4}
E - HI > 1 or ELCR > 10^{-4}

Industrial Scenario

For industrial workers exposed to surface soil, the combined cancer risk under RME assumptions is 1×10^{-7}, which falls below the target cancer risk of 1×10^{-4}. The combined RME HI of 4×10^{-4} falls below the target HI of 1. The 95th percentile mean blood lead concentration in the fetus of the industrial worker is 8 µg/dL, which is below the CDC target of 10 µg/dL. Therefore, no COCs were identified for the industrial worker at Study Area 10–West.

Construction Scenario

For construction workers exposed to surface soil, the combined cancer risk under RME assumptions is 3×10^{-8}, which falls below the target cancer risk of 1×10^{-4}. Cancer risks were not quantified for subsurface soil because none of the subsurface soil COPCs has a toxicity value for cancer effects. The combined RME HIs of 8×10^{-4} for surface soil exposure and 0.01 for subsurface soil exposure fall below the target HI of 1. The 95th percentile mean blood lead concentration in the fetus of the construction worker exposed to surface soil is 9 µg/dL, which is below the CDC target of 10 µg/dL. Therefore, no COCs were identified for the construction worker at Study Area 10–West.

Recreational Scenario

For recreational receptors exposed to surface soil, the combined RME cancer risk for the integrated child or adult receptor is 4×10^{-8}, which is below the target cancer risk of 1×10^{-4}. The combined RME HIs of 1×10^{-4} for the child and 9×10^{-5} for the adult fall below the target HI of 1. Therefore, no COCs were identified for recreational receptors at Study Area 10–West.

Residential Scenario

The combined RME cancer risk for the integrated child or adult resident is 4×10^{-7} for exposure to surface soil. Both fall below the target cancer risk of 1×10^{-4}. Cancer risks were not quantified for subsurface soil because none of the subsurface soil COPCs has a toxicity value for cancer effects. For noncancer effects, the combined RME HIs are 0.003 and 0.3 (surface and subsurface soil exposures, respectively for the child) and 0.0007 and 0.06 (surface and subsurface soil exposures, respectively for the adult). All are below the target HI of 1. The 95th percentile mean blood lead concentration in the resident child exposed to surface soil is 13 µg/dL, which is above the CDC target of 10 µg/dL. Therefore, the following COC was identified for residents at Study Area 10–West:

- lead: surface soil, 95th percentile mean blood lead level = 13 µg/dL

6.4.4.13 Study Area 16 – Flashing Ground

The pathways evaluated at Study Area 16 are soil ingestion, dermal contact, and inhalation of suspended soil particulates for all receptors and ingestion of rabbit for recreational and resident receptors. One surface water and one sediment sample were collected from an area of ponded drainage at Study Area 16. In the sediment sample, all chemicals were eliminated as COPCs in the background comparison and RBC screen. COPCs were identified in the surface water sample and risks were calculated for these COPCs (i.e., ingestion and dermal contact exposures for residents and recreational receptors). The RME risk characterization summary for Study Area 16 is presented in **Table 6-42** and COCs for each pathway and receptor are listed in **Table 6-43**.

The maximum detected concentration of lead in soil at Study Area 16 exceeds the 400 ppm screening level in surface and subsurface soils (EPA 1995c). Therefore, models were used to estimate blood lead levels in resident children, industrial workers, and construction workers.

Industrial Scenario

For industrial workers exposed to surface soil, the combined cancer risk under RME assumptions is 3×10^{-5}, which falls below the target cancer risk of 1×10^{-4}. The combined RME HI of 0.6 falls below the target HI of 1. The 95th percentile mean blood lead concentration in the fetus of the industrial worker is 9 µg/dL, which is below the CDC target of 10 µg/dL. Therefore, no COCs were identified for the industrial worker at Study Area 16.

Construction Scenario

For construction workers exposed to soil, the combined cancer risks under RME assumptions are 1×10^{-5} for surface soil exposure and 2×10^{-6} for subsurface soil exposure. The combined RME HIs are 2 for surface soil exposure and 1 for subsurface soil exposure. The former exceeds the target HI of 1. Noncancer effects were segregated according to target organ. The medium TOHIs for surface soil do not exceed the target HI. The 95th percentile mean blood lead concentration in the fetus of the construction worker is 11 µg/dL for surface soil exposure and 9 µg/dL for subsurface soil exposure. The former is above the CDC target of 10 µg/dL. Therefore, the following COC was identified for the construction worker at Study Area 16:

- lead: surface soil, 95th percentile mean blood lead level = 11 µg/dL

Recreational Scenario

For recreational receptors exposed to surface soil and ingesting rabbit, the combined RME cancer risk for the integrated child or adult receptor is 1×10^{-5}, which is below the target cancer risk of 1×10^{-4}. The combined RME HIs of 0.2 (surface soil, surface water, and rabbit ingestion exposure) for the child and the adult fall below the target HI of 1. Therefore, no COCs were identified for recreational receptors at Study Area 16.

Table 6-42. RME Risk Characterization Summary for Study Area 16 (Current/Future and Future Land Use) Flashing Ground, Alabama Army Ammunition Plant, Childersburg, Alabama

Medium	Exposure Route	Cancer Risk: Industrial Worker	Cancer Risk: Construction Worker	Cancer Risk: Recreational Child	Cancer Risk: Recreational Adult	Cancer Risk: Residential Child	Cancer Risk: Residential Adult	Noncancer HI: Industrial Worker	Noncancer HI: Construction Worker	Noncancer HI: Recreational Child	Noncancer HI: Recreational Adult	Noncancer HI: Residential Child	Noncancer HI: Residential Adult
Surface Soil (0 to <1 ft BLS)	Ingestion	1E-05 B	9E-06 B	8E-06 B	8E-06 B	1E-04 B	1E-04 B	2E-01 B	2E+00 E	1E-01 B	7E-02 B	5E+00 E	5E-01 B
	Dermal Contact	2E-05 B	2E-06 B	6E-06 B	6E-06 B	4E-05 B	4E-05 B	4E-01 B	4E-01 B	8E-02 B	7E-02 B	8E-01 B	5E-01 B
	Inhalation	1E-06 B	1E-07 B	2E-07 B	2E-07 B	3E-06 B	3E-06 B	3E-03 B	4E-03 B	6E-04 B	3E-04 B	1E-02 B	4E-03 B
	Subtotal	**3E-05 B**	**1E-05 B**	**1E-05 B**	**1E-05 B**	**2E-04 E**	**2E-04 E**	**6E-01 B**	**2E+00 E**	**2E-01 B**	**1E-01 B**	**6E+00 E**	**1E+00 B**
Subsurface Soil (1 to 10 ft BLS)	Ingestion	NA	2E-06 B	NA	NA	2E-05 B	2E-05 B	NA	9E-01 B	NA	NA	3E+00 E	3E-01 B
	Dermal Contact	NA	4E-07 B	NA	NA	9E-06 B	9E-06 B	NA	2E-01 B	NA	NA	4E-01 B	3E-01 B
	Inhalation	NA	2E-10 B	NA	NA	5E-09 B	5E-09 B	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**2E-06 B**	**NA**	**NA**	**3E-05 B**	**3E-05 B**	**NA**	**1E+00 B**	**NA**	**NA**	**3E+00 E**	**5E-01 B**
Sediment	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Surface Water	Ingestion	NA	NA	4E-08 B	4E-08 B	1E-07 B	1E-07 B	NA	NA	7E-03 B	9E-04 B	4E-02 B	2E-03 B
	Dermal Contact	NA	NA	4E-08 B	4E-08 B	7E-08 B	7E-08 B	NA	NA	9E-03 B	9E-03 B	2E-02 B	2E-02 B
	Subtotal	**NA**	**NA**	**8E-08 B**	**8E-08 B**	**2E-07 B**	**2E-07 B**	**NA**	**NA**	**2E-02 B**	**9E-03 B**	**6E-02 B**	**2E-02 B**
Groundwater	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Rabbit	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	1E-02 B	8E-03 B	4E-02 B	2E-02 B
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**1E-02 B**	**8E-03 B**	**4E-02 B**	**2E-02 B**
Fish	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Surface Soil (0 to <1 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								6E-01 B	2E+00 E	2E-01 B	2E-01 B	6E+00 E	1E+00 B
Combined Cancer Risk:		3E-05 B	1E-05 B	1E-05 B	1E-05 B	2E-04 E	2E-04 E						
Subsurface Soil (1 to 10 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	1E+00 B	3E-02 B	2E-02 B	3E+00 E	6E-01 B
Combined Cancer Risk:		NA	2E-06 B	8E-08 B	8E-08 B	3E-05 B	3E-05 B						

NA - pathway not evaluated or all detected chemicals eliminated as COPCs
0E+00 - pathway evaluated but no risks could be calculated due to lack of EPA-approved toxicity values
B - HI ≤ 1 or ELCR ≤ 10^{-4}
E - HI > 1 or ELCR > 10^{-4}

Table 6-43. Summary of Receptor Risks and Hazards for COCs at Study Area 16
Reasonable Maximum Exposure
Flashing Ground, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Soil	Flashing Ground	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	6.270E-05	--	3.737E-06	6.644E-05	Arsenic	--	--	--	--	--
			Cadmium	--	--	--	--	Cadmium	--	--	--	--	--
			Copper	--	--	--	--	Copper	--	--	--	--	--
			Iron	--	--	--	--	Iron		2.17	--	0.146	2.32
			Mercury	--	--	--	--	Mercury	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			Benzo(a)anthracene	2.971E-06	--	2.342E-06	5.314E-06	Benzo(a)anthracene	--	--	--	--	--
			Benzo(a)pyrene	3.200E-05	--	2.522E-05	5.722E-05	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	5.029E-06	--	3.964E-06	8.992E-06	Benzo(b)fluoranthene	--	--	--	--	--
			Dibenzo(a,h)anthracene	4.343E-06	--	3.423E-06	7.766E-06	Dibenzo(a,h)anthracene	--	--	--	--	--
			Indeno(1,2,3-cd)pyrene	1.600E-06	--	1.261E-06	2.861E-06	Indeno(1,2,3-cd)pyrene	--	--	--	--	--
			(Total)	0.000109	--	3.995E-05	0.000149	(Total)	--	2.17	--	0.146	2.32
	Air	Flashing Ground	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	1.911E-06	--	1.911E-06	Arsenic	--	--	--	--	--
			Cadmium	--	--	--	--	Cadmium	--	--	--	--	--
			Copper	--	--	--	--	Copper	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Mercury	--	--	--	--	Mercury	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			Benzo(a)anthracene	--	--	--	--	Benzo(a)anthracene	--	--	--	--	--
			Benzo(a)pyrene	--	--	--	--	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	--	--	--	--	Benzo(b)fluoranthene	--	--	--	--	--
			Dibenzo(a,h)anthracene	--	--	--	--	Dibenzo(a,h)anthracene	--	--	--	--	--
			Indeno(1,2,3-cd)pyrene	--	--	--	--	Indeno(1,2,3-cd)pyrene	--	--	--	--	--
			(Total)	--	1.911E-06	--	1.911E-06	(Total)	--	--	--	--	--
Subsurface Soil	Soil	Flashing Ground	Copper	--	--	--	--	Copper	--	--	--	--	--
			2,4,6-Trinitrotoluene	--	--	--	--	2,4,6-Trinitrotoluene	liver	2.43	--	0.407	2.84
			2,4-Dinitrotoluene	--	--	--	--	2,4-Dinitrotoluene	--	--	--	--	--
			Benzo(a)pyrene	--	--	--	--	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	--	--	--	--	Benzo(b)fluoranthene	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	2.43	--	0.407	2.84
	Air	Flashing Ground	Copper	--	--	--	--	Copper	--	--	--	--	--
			2,4,6-Trinitrotoluene	--	--	--	--	2,4,6-Trinitrotoluene	--	--	--	--	--
			2,4-Dinitrotoluene	--	--	--	--	2,4-Dinitrotoluene	--	--	--	--	--
			Benzo(a)pyrene	--	--	--	--	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	--	--	--	--	Benzo(b)fluoranthene	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
Surface Water	Surface Water	Flashing Ground	Cobalt	--	--	--	--	Cobalt	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			2,4,6-Trinitrotoluene	--	--	--	--	2,4,6-Trinitrotoluene	--	--	--	--	--
			2,4-Dinitrotoluene	--	--	--	--	2,4-Dinitrotoluene	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
Rabbit	Tissue	Flashing Ground	Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Nickel	--	--	--	--	Nickel	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--

Residential Scenario

The combined RME cancer risks for the integrated child or adult resident are 2×10^{-4} for exposure to surface soil, which are above the target cancer risk of 1×10^{-4}, and 3×10^{-5} for exposure to subsurface soil. Cancer effects were not quantified for ingestion of rabbit because none of the COPCs in rabbit tissue has a toxicity value for cancer effects. For noncancer effects, the combined RME HIs are 6 (surface soil exposure and rabbit ingestion for the child) and 3 (subsurface soil exposure and rabbit ingestion for the child). For the adult, the combined RME HIs are 1 (surface soil and surface water exposure and rabbit ingestion) and 0.6 (subsurface soil and surface water exposure and rabbit ingestion). Noncancer effects were segregated according to target organ. In subsurface soil, the medium TOHI for the liver exceeds the target HI for the child and the adult. The 95th percentile mean blood lead concentration in the resident child is 18 µg/dL for exposure to surface soil and 12 µg/dL for exposure to subsurface soil, which are above the CDC target of 10 µg/dL. The following COCs were identified for residents at Study Area 16 based on cancer and noncancer effects:

- arsenic: surface soil ingestion cancer risk = 6×10^{-5}
  surface soil dermal contact cancer risk = 4×10^{-6}
  surface soil inhalation cancer risk = 2×10^{-6}
- iron: surface soil ingestion HQ = 2 (child)
  surface soil dermal contact HQ = 0.1 (child)
- lead: surface soil, 95th percentile mean blood lead level = 18 µg/dL
  subsurface soil, 95th percentile mean blood lead level = 12 µg/dL
- benzo(a)anthracene: surface soil ingestion cancer risk = 3×10^{-6}
  surface soil dermal contact cancer risk = 2×10^{-6}
- benzo(a)pyrene: surface soil ingestion cancer risk = 3×10^{-5}
  surface soil dermal contact cancer risk = 3×10^{-5}
- benzo(b)fluoranthene: surface soil ingestion cancer risk = 5×10^{-6}
  surface soil dermal contact cancer risk = 4×10^{-6}
- dibenzo(a,h)anthracene: surface soil ingestion cancer risk = 4×10^{-6}
  surface soil dermal contact cancer risk = 3×10^{-6}
- indeno(1,2,3-cd)pyrene: surface soil ingestion cancer risk = 2×10^{-6}
  surface soil dermal contact cancer risk = 1×10^{-6}
- 2,4,6-trinitrotoluene: subsurface soil ingestion HQ = 2 (child)
  subsurface soil dermal contact HQ = 0.4 (child)

6.4.4.14 Study Area 17 -- Propellant Shipping Area

The pathways evaluated at Study Area 17 are soil ingestion, dermal contact, and inhalation of suspended soil particulates for all receptors and ingestion of rabbit for recreational and resident receptors. The RME risk characterization summary for Study Area 17 is presented in **Table 6-44**, and COCs for each pathway and receptor are listed in **Tables 6-45** through **6-47**.

Industrial Scenario

For industrial workers exposed to surface soil, the combined cancer risk under RME assumptions is 2×10^{-5}, which falls below the target cancer risk of 1×10^{-4}. The combined RME HI of 1 equals but does not exceed the target HI of 1. Therefore, no COCs were identified for the industrial worker at Study Area 17.

Construction Scenario

For construction workers exposed to soil, the combined cancer risks under RME assumptions are 1×10^{-5} both for surface and subsurface soil exposure. Each is below the target cancer risk of 1×10^{-4}. The combined RME HIs are 3 for surface soil exposure and 1 for subsurface soil exposure. The former exceeds the target HI of 1. Noncancer effects were segregated according to target organ. The medium TOHI for the central nervous system for surface soil exceeds the target HI. In subsurface soil, the medium TOHIs do not exceed the target HI. The following COC was identified based on noncancer effects:

- manganese: surface soil ingestion HQ = 0.5
  surface soil dermal contact HQ = 0.1
  surface soil inhalation HQ = 1

Recreational Scenario

For recreational receptors exposed to surface soil and ingesting rabbit, the combined RME cancer risk for the integrated child or adult receptor is 2×10^{-5}, which is below the target cancer risk of 1×10^{-4}. The combined RME HIs of 0.4 for the child and 0.2 for the adult fall below the target HI of 1. Therefore, no COCs were identified for recreational receptors at Study Area 17.

Residential Scenario

The combined RME cancer risks for the integrated child or adult resident are 1×10^{-4} for exposure to surface soil and ingestion of rabbit and 2×10^{-4} for exposure to subsurface soil and ingestion of rabbit. For noncancer effects, the combined RME HIs are 10 (surface soil exposure and rabbit ingestion for the child) and 4 (subsurface soil exposure and rabbit ingestion for the child). For the adult, the combined RME HIs are 9 (surface soil exposure and rabbit ingestion) and

Table 6-44. RME Risk Characterization Summary for Study Area 17 (Current/Future and Future Land Uses) Propellant Shipping Area, Alabama Army Ammunition Plant, Childersburg, Alabama

Medium	Exposure Route	Cancer Risk: Industrial Worker	Cancer Risk: Construction Worker	Cancer Risk: Recreational Child	Cancer Risk: Recreational Adult	Cancer Risk: Residential Child	Cancer Risk: Residential Adult	Noncancer HI: Industrial Worker	Noncancer HI: Construction Worker	Noncancer HI: Recreational Child	Noncancer HI: Recreational Adult	Noncancer HI: Residential Child	Noncancer HI: Residential Adult
Surface Soil (0 to <1 ft BLS)	Ingestion	1E-05 B	9E-06 B	8E-06 B	8E-06 B	1E-04 B	1E-04 B	2E-01 B	2E+00 E	1E-01 B	8E-02 B	5E+00 E	6E-01 B
	Dermal Contact	3E-06 B	3E-07 B	1E-06 B	1E-06 B	7E-06 B	7E-06 B	2E-01 B	2E-01 B	5E-02 B	5E-02 B	5E-01 B	3E-01 B
	Inhalation	1E-06 B	1E-07 B	2E-07 B	2E-07 B	3E-06 B	3E-06 B	9E-01 B	1E+00 B	2E-01 B	8E-02 B	4E+00 E	1E+00 B
	Subtotal	**2E-05 B**	**1E-05 B**	**9E-06 B**	**9E-06 B**	**1E-04 B**	**1E-04 B**	**1E+00 B**	**3E+00 E**	**4E-01 B**	**2E-01 B**	**1E+01 E**	**2E+00 E**
Subsurface Soil (1 to 10 ft BLS)	Ingestion	NA	1E-05 B	NA	NA	1E-04 B	1E-04 B	NA	1E+00 B	NA	NA	3E+00 E	3E-01 B
	Dermal Contact	NA	3E-07 B	NA	NA	8E-06 B	8E-06 B	NA	6E-02 B	NA	NA	2E-01 B	1E-01 B
	Inhalation	NA	2E-07 B	NA	NA	6E-06 B	6E-06 B	NA	3E-01	NA	NA	1E+00 B	3E-01 B
	Subtotal	**NA**	**1E-05 B**	**NA**	**NA**	**1E-04 B**	**1E-04 B**	**NA**	**1E+00 B**	**NA**	**NA**	**4E+00 E**	**7E-01 B**
Sediment	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Surface Water	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Groundwater	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Rabbit	Ingestion	NA	NA	9E-06 B	9E-06 B	2E-05 B	2E-05 B	NA	NA	5E-02 B	3E-02 B	2E-01 B	7E-02 B
	Subtotal	**NA**	**NA**	**9E-06 B**	**9E-06 B**	**2E-05 B**	**2E-05 B**	**NA**	**NA**	**5E-02 B**	**3E-02 B**	**2E-01 B**	**7E-02 B**
Fish	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Surface Soil (0 to <1 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								1E+00 B	3E+00 E	4E-01 B	2E-01 B	1E+01 E	2E+00 E
Combined Cancer Risk:		2E-05 B	1E-05 B	2E-05 B	2E-05 B	1E-04 B	1E-04 B						
Subsurface Soil (1 to 10 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	1E+00 B	5E-02 B	3E-02 B	4E+00 E	8E-01 B
Combined Cancer Risk:		NA	1E-05 B	9E-06 B	9E-06 B	2E-04 E	2E-04 E						

NA - pathway not evaluated or all detected chemicals eliminated as COPCs
0E+00 - pathway evaluated but no risks could be calculated due to lack of EPA-approved toxicity values
B - HI $\leq$ 1 or ELCR $\leq 10^{-4}$
E - HI > 1 or ELCR > 10^{-4}

Table 6-45. Summary of Receptor Risks and Hazards for COCs at Study Area 17
Reasonable Maximum Exposure
Propellant Shipping Area, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Soil	Propellant Shipping Area	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	0.470	--	0.142	0.612
			(Total)	--	--	--	--	(Total)	--	0.47	--	0.142	0.61
	Air	Propellant Shipping Area	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	--	1.07	--	1.07
			(Total)	--	--	--	--	(Total)	--	--	1.07	--	1.07
Subsurface Soil	Soil	Propellant Shipping Area	Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
	Air	Propellant Shipping Area	Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--

Table 6-46. Summary of Receptor Risks and Hazards for COCs at Study Area 17
Reasonable Maximum Exposure
Propellant Shipping Area, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Soil	Propellant Shipping Area	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	skin	1.99	--	0.0487	2.03
			Iron	--	--	--	--	Iron	--	1.70	--	0.114	1.82
			Manganese	--	--	--	--	Manganese	CNS	1.28	--	0.321	1.60
			(Total)	--	--	--	--	(Total)	--	4.97	--	0.484	5.45
	Air	Propellant Shipping Area	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	--	4.35	--	4.35
			(Total)	--	--	--	--	(Total)	--	--	4.35	--	4.35
Subsurface Soil	Soil	Propellant Shipping Area	Arsenic	--	--	--	--	Arsenic	skin	2.31	--	0.0565	2.36
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	0.323	--	0.0811	0.404
			(Total)	--	--	--	--	(Total)	--	2.63	--	0.138	2.77
	Air	Propellant Shipping Area	Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	--	1.10	--	1.10
			(Total)	--	--	--	--	(Total)	--	--	1.10	--	1.10
Rabbit	Tissue	Propellant Shipping Area	Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			bis(2-Ethylhexyl)phthalate	--	--	--	--	bis(2-Ethylhexyl)phthalate	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--

Table 6-47. Summary of Receptor Risks and Hazards for COCs at Study Area 17
Reasonable Maximum Exposure
Propellant Shipping Area, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Soil	Propellant Shipping Area	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	0.137	--	0.199	0.336
			(Total)	--	--	--	--	(Total)	--	0.137	--	0.199	0.336
	Air	Propellant Shipping Area	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	--	1.24	--	1.24
			(Total)	--	--	--	--	(Total)	--	--	1.24	--	1.24
Subsurface Soil	Soil	Propellant Shipping Area	Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
	Air	Propellant Shipping Area	Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
Rabbit	Tissue	Propellant Shipping Area	Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			bis(2-Ethylhexyl)phthalate	--	--	--	--	bis(2-Ethylhexyl)phthalate	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--

3 (subsurface soil exposure and rabbit ingestion). Noncancer effects were segregated according to target organ. In surface and subsurface soil, the medium TOHIs for the skin and central nervous system exceed the target HI for the child, and only the central nervous system TOHI exceeds the target HI for the adult. The following COCs were identified for residents at Study Area 17 based on noncancer effects:

- arsenic: surface soil ingestion HQ = 2 (child)
  subsurface soil ingestion HQ = 2 (child)
- iron: surface soil ingestion HQ = 2 (child)
  surface soil dermal contact HQ = 0.1 (child)
- manganese: surface soil ingestion HQ = 1 (child), 0.1 (adult)
  surface soil dermal contact HQ = 0.3 (child), 0.2 (adult)
  surface soil inhalation HQ = 4 (child), 1 (adult)
  subsurface soil ingestion HQ = 0.3 (child)
  subsurface soil inhalation HQ = 1 (child)

6.4.4.15 Study Area 18 – Blending Tower Area

The pathways evaluated at Study Area 18 are soil ingestion, dermal contact, and inhalation of suspended soil particulates for all receptors. The RME risk characterization summary for Study Area 18 is presented in **Table 6-48**, and COCs for each pathway and receptor are listed in **Tables 6-49** and **6-50**.

Industrial Scenario

For industrial workers exposed to surface soil, the combined cancer risk under RME assumptions is 2×10^{-5}, which falls below the target cancer risk of 1×10^{-4}. The combined RME HI of 1 equals but does not exceed the target HI of 1. Therefore, no COCs were identified for the industrial worker at Study Area 18.

Construction Scenario

For construction workers exposed to soil, the combined cancer risks under RME assumptions are 9×10^{-6} for surface soil exposure and 5×10^{-8} for subsurface soil exposure. The combined RME HIs are 3 for surface soil exposure and 1 for subsurface soil exposure. The former exceeds the target HI of 1. Noncancer effects were segregated according to target organ. The medium TOHIs for surface soil do not exceed the target HI. Therefore, no COCs were identified for the construction worker at Study Area 18.

Table 6-48. RME Risk Characterization Summary for Study Area 18 (Current/Future and Future Land Uses) Blending Tower Area, Alabama Army Ammunition Plant, Childersburg, Alabama

Medium	Exposure Route	Cancer Risk: Industrial Worker	Cancer Risk: Construction Worker	Cancer Risk: Recreational Child	Cancer Risk: Recreational Adult	Cancer Risk: Residential Child	Cancer Risk: Residential Adult	Noncancer HI: Industrial Worker	Noncancer HI: Construction Worker	Noncancer HI: Recreational Child	Noncancer HI: Recreational Adult	Noncancer HI: Residential Child	Noncancer HI: Residential Adult
Surface Soil (0 to <1 ft BLS)	Ingestion	1E-05 B	8E-06 B	7E-06 B	7E-06 B	1E-04 B	1E-04 B	2E-01 B	2E+00 E	1E-01 B	8E-02 B	5E+00 E	5E-01 B
	Dermal Contact	3E-06 B	2E-07 B	8E-07 B	8E-07 B	6E-06 B	6E-06 B	3E-01 B	3E-01 B	6E-02 B	5E-02 B	6E-01 B	4E-01 B
	Inhalation	2E-06 B	2E-07 B	3E-07 B	3E-07 B	4E-06 B	4E-06 B	7E-01 B	8E-01 B	1E-01 B	6E-02 B	3E+00 E	9E-01 B
	Subtotal	**2E-05 B**	**9E-06 B**	**8E-06 B**	**8E-06 B**	**1E-04 B**	**1E-04 B**	**1E+00 B**	**3E+00 E**	**3E-01 B**	**2E-01 B**	**9E+00 E**	**2E+00 E**
Subsurface Soil (1 to 10 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	NA	3E-01 B	NA	NA	9E-01 B	9E-02 B
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	1E-01 B	NA	NA	2E-01 B	1E-01 B
	Inhalation	NA	5E-08 B	NA	NA	1E-06 B	1E-06 B	NA	7E-01	NA	NA	3E+00 E	8E-01 B
	Subtotal	**NA**	**5E-08 B**	**NA**	**NA**	**1E-06 B**	**1E-06 B**	**NA**	**1E+00 B**	**NA**	**NA**	**4E+00 E**	**1E+00 B**
Sediment	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface Water	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Groundwater	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Rabbit	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fish	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface Soil (0 to <1 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								1E+00 B	3E+00 E	3E-01 B	2E-01 B	9E+00 E	2E+00 E
Combined Cancer Risk:		2E-05 B	9E-06 B	8E-06 B	8E-06 B	1E-04 B	1E-04 B						
Subsurface Soil (1 to 10 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	1E+00 B	NA	NA	4E+00 E	1E+00 B
Combined Cancer Risk:		NA	5E-08 B	NA	NA	1E-06 B	1E-06 B						

NA - pathway not evaluated or all detected chemicals eliminated as COPCs
0E+00 - pathway evaluated but no risks could be calculated due to lack of EPA-approved toxicity values
B - HI ≤ 1 or ELCR ≤ 10^{-4}
E - HI > 1 or ELCR > 10^{-4}

Table 6-49. Summary of Receptor Risks and Hazards for COCs at Study Area 18
Reasonable Maximum Exposure
Blending Tower Area, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Soil	Blending Tower Area	Arsenic	--	--	--	--	Arsenic	skin	1.73	--	0.0425	1.78
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	2.10	--	0.141	2.24
			Manganese	--	--	--	--	Manganese	CNS	0.954	--	0.240	1.19
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	4.79	--	0.423	5.21
	Air	Blending Tower Area	Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	--	3.25	--	3.25
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	3.25	--	3.25
Subsurface Soil	Soil	Blending Tower Area	Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	0.852	--	0.214	1.07
			(Total)	--	--	--	--	(Total)	--	0.852	--	0.214	1.07
	Air	Blending Tower Area	Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	--	2.90	--	2.90
			(Total)	--	--	--	--	(Total)	--	--	2.90	--	2.90

Table 6-50. Summary of Receptor Risks and Hazards for COCs at Study Area 18
Reasonable Maximum Exposure
Blending Tower Area, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Soil	Blending Tower Area	Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	0.102	--	0.148	0.250
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	0.102	--	0.148	0.250
	Air	Blending Tower Area	Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	--	0.928	--	0.928
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	0.928	--	0.928
Subsurface Soil	Soil	Blending Tower Area	Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
	Air	Blending Tower Area	Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--

Recreational Scenario

For recreational receptors exposed to surface soil, the combined RME cancer risk for the integrated child or adult receptor is 8×10^{-6}, which is below the target cancer risk of 1×10^{-4}. The combined RME HIs of 0.3 for the child and 0.2 for the adult fall below the target HI of 1. Therefore, no COCs were identified for recreational receptors at Study Area 18.

Residential Scenario

The combined RME cancer risks for the integrated child or adult resident are 1×10^{-4} for exposure to surface soil and 1×10^{-6} for exposure to subsurface soil. Both are at or below the target cancer risk of 1×10^{-4}. For noncancer effects, the combined RME HIs are 9 and 4 (surface and subsurface soil exposures, respectively for the child) and 2 and 1 (surface and subsurface soil exposures, respectively for the adult). Noncancer effects were segregated according to target organ. For the resident child and adult, the medium TOHIs for the central nervous system exceed the target HI in surface and subsurface soils. In addition, the medium TOHI for the skin exceeds the target HI in surface soil for the resident child. The following COCs were identified for residents at Study Area 18 based on noncancer effects:

- arsenic: surface soil ingestion HQ = 2 (child)
- iron: surface soil ingestion HQ = 2 (child)
surface soil dermal contact HQ = 0.1 (child)
- manganese: surface soil ingestion HQ = 1 (child), 0.1 (adult)
surface soil dermal contact HQ = 0.2 (child), 0.1 (adult)
surface soil inhalation HQ = 3 (child), 1 (adult)
subsurface soil ingestion HQ = 0.9 (child), 0.09 (adult)
subsurface soil dermal contact HQ = 0.2 (child), 0.1 (adult)
subsurface soil inhalation HQ = 3 (child), 0.8 (adult)

6.4.4.16 Study Area 19 – Lead Facility

The pathways evaluated at Study Area 19 are soil ingestion, dermal contact, and inhalation of suspended soil particulates for all receptors. The RME risk characterization summary for Study Area 19 is presented in **Table 6-51**, and COCs are listed in **Table 6-52**.

The maximum detected concentration of lead at Study Area 19 exceeds the 400 ppm screening level in surface soil (EPA 1995c). Therefore, models were used to estimate blood lead levels in resident children, industrial workers, and construction workers.

Table 6-51. RME Risk Characterization Summary for Study Area 19 (Current/Future and Future Land Uses) Lead Facility, Alabama Army Ammunition Plant, Childersburg, Alabama

Medium	Exposure Route	Cancer Risk: Industrial Worker	Cancer Risk: Construction Worker	Cancer Risk: Recreational Child	Cancer Risk: Recreational Adult	Cancer Risk: Residential Child	Cancer Risk: Residential Adult	Noncancer HI: Industrial Worker	Noncancer HI: Construction Worker	Noncancer HI: Recreational Child	Noncancer HI: Recreational Adult	Noncancer HI: Residential Child	Noncancer HI: Residential Adult
Surface Soil (0 to <1 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	2E-03 B	3E-03 B	1E-03 B	7E-04 B	5E-02 B	5E-03 B
	Dermal Contact	NA	NA	NA	NA	NA	NA	1E-02 B	3E-03 B	2E-03 B	2E-03 B	2E-02 B	2E-02 B
	Inhalation	8E-07 B	8E-08 B	1E-07 B	1E-07 B	2E-06 B	2E-06 B	2E-03 B	2E-03 B	4E-04 B	2E-04 B	1E-02 B	3E-03 B
	Subtotal	**8E-07 B**	**8E-08 B**	**1E-07 B**	**1E-07 B**	**2E-06 B**	**2E-06 B**	**1E-02 B**	**8E-03 B**	**4E-03 B**	**3E-03 B**	**8E-02 B**	**2E-02 B**
Subsurface Soil (1 to 10 ft BLS)	Ingestion	NA	1E-05 B	NA	NA	1E-04 B	1E-04 B	NA	8E-01 B	NA	NA	2E+00 E	2E-01 B
	Dermal Contact	NA	3E-07 B	NA	NA	7E-06 B	7E-06 B	NA	2E-02 B	NA	NA	5E-02 B	3E-02 B
	Inhalation	NA	1E-07 B	NA	NA	4E-06 B	4E-06 B	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**1E-05 B**	**NA**	**NA**	**1E-04 B**	**1E-04 B**	**NA**	**8E-01 B**	**NA**	**NA**	**2E+00 E**	**3E-01 B**
Sediment	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Surface Water	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Groundwater	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Rabbit	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Fish	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Surface Soil (0 to <1 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								1E-02 B	8E-03 B	4E-03 B	3E-03 B	8E-02 B	2E-02 B
Combined Cancer Risk:		8E-07 B	8E-08 B	1E-07 B	1E-07 B	2E-06 B	2E-06 B						
Subsurface Soil (1 to 10 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	8E-01 B	NA	NA	2E+00 E	3E-01 B
Combined Cancer Risk:		NA	1E-05 B	NA	NA	1E-04 B	1E-04 B						

NA - pathway not evaluated or all detected chemicals eliminated as COPCs
0E+00 - pathway evaluated but no risks could be calculated due to lack of EPA-approved toxicity values
B - HI < 1 or ELCR < 10^{-4}
E - HI > 1 or ELCR > 10^{-4}

Table 6-52. Summary of Receptor Risks and Hazards for COCs at Study Area 19
Reasonable Maximum Exposure
Lead Facility, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Soil	Lead Facility	Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
	Air	Lead Facility	Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
Subsurface Soil	Soil	Lead Facility	Arsenic	--	--	--	--	Arsenic	skin	2.14	--	0.0525	2.20
			(Total)	--	--	--	--	(Total)	--	2.14	--	0.0525	2.20
	Air	Lead Facility	Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--

Industrial Scenario

For industrial workers exposed to surface soil, the combined cancer risk under RME assumptions is 8×10^{-7}, which falls below the target cancer risk of 1×10^{-4}. The combined RME HI of 0.01 falls below the target HI of 1. The 95th percentile mean blood lead concentration in the fetus of the industrial worker is 7 µg/dL, which is below the CDC target of 10 µg/dL. Therefore, no COCs were identified for the industrial worker at Study Area 19.

Construction Scenario

For construction workers exposed to soil, the combined cancer risks under RME assumptions are 8×10^{-8} for surface soil exposure and 1×10^{-5} for subsurface soil exposure. Both fall below the target cancer risk of 1×10^{-4}. The combined RME HIs of 0.008 for surface soil exposure and 0.8 for subsurface soil exposure fall below the target HI of 1. The 95th percentile mean blood lead concentration in the fetus of the construction worker exposed to surface soil is 7 µg/dL, which is below the CDC target of 10 µg/dL. Therefore, no COCs were identified for the construction worker at Study Area 19.

Recreational Scenario

For recreational receptors exposed to surface soil, the combined RME cancer risk for the integrated child or adult receptor is 1×10^{-7}, which is below the target cancer risk of 1×10^{-4}. The combined RME HIs of 0.004 for the child and 0.003 for the adult fall below the target HI of 1. Therefore, no COCs were identified for recreational receptors at Study Area 19.

Residential Scenario

The combined RME cancer risks for the integrated child or adult resident are 2×10^{-6} for exposure to surface soil and 1×10^{-4} for exposure to subsurface soil. Both are at or below the target cancer risk of 1×10^{-4}. For noncancer effects, the combined RME HIs are 0.08 and 2 (surface and subsurface soil exposures, respectively for the child) and 0.02 and 0.3 (surface and subsurface soil exposures, respectively for the adult). Noncancer effects were segregated according to target organ. For the resident child, the medium TOHI for the skin exceeds the target HI in subsurface soil. The 95th percentile mean blood lead concentration for the resident child is 6 µg/dL, which is below the CDC target of 10 µg/dL. The following COC was identified for the resident child at Study Area 19 based on noncancer effects:

- arsenic: subsurface soil ingestion HQ = 2 (child)

6.4.4.17 Study Area 20 – Rifle Powder Finishing Area

The pathways evaluated at Study Area 20 are soil ingestion, dermal contact, and inhalation of suspended soil particulates for all receptors. The RME risk characterization summary for Study Area 20 is presented in **Table 6-53**, and COCs are listed in **Table 6-54**.

Industrial Scenario

For industrial workers exposed to surface soil, the combined cancer risk under RME assumptions is 8×10^{-6}, which falls below the target cancer risk of 1×10^{-4}. The combined RME HI of 0.08 falls below the target HI of 1. Therefore, no COCs were identified for the industrial worker at Study Area 20.

Construction Scenario

For construction workers exposed to soil, the combined cancer risk under RME assumptions is 4×10^{-6}, which is below the target cancer risk of 1×10^{-4}. Cancer risks for subsurface soil were not quantified because none of the subsurface soil COPCs has a toxicity value for cancer effects. The combined RME HIs of 0.5 for surface soil exposure and 1 for subsurface soil exposure are at or below the target HI of 1. Therefore, no COCs were identified for the construction worker at Study Area 20.

Recreational Scenario

For recreational receptors exposed to surface soil, the combined RME cancer risk for the integrated child or adult receptor is 4×10^{-6}, which is below the target cancer risk of 1×10^{-4}. The combined RME HIs of 0.04 for the child and 0.02 for the adult fall below the target HI of 1. Therefore, no COCs were identified for recreational receptors at Study Area 20.

Residential Scenario

The combined RME cancer risk for the integrated child or adult resident is 5×10^{-5} for exposure to surface soil, which is below the target cancer risk of 1×10^{-4}. Cancer risks for subsurface soil were not quantified because none of the subsurface soil COPCs has a toxicity value for cancer effects. For noncancer effects, the combined RME HIs are 1 and 4 (surface and subsurface soil exposures, respectively for the child) and 0.2 and 0.6 (surface and subsurface soil exposures, respectively for the adult). Noncancer effects were segregated according to target organ. Only one COC was identified for the resident child at Study Area 20 based on noncancer effects:

- iron: subsurface soil ingestion HQ = 2 (child)
  subsurface soil dermal contact HQ = 0.2 (child)

Table 6-53. RME Risk Characterization Summary for Study Area 20 (Current/Future and Future Land Uses) Rifle Powder Finishing Area, Alabama Army Ammunition Plant, Childersburg, Alabama

Medium	Exposure Route	Cancer Risk						Noncancer HI					
		Industrial Worker	Construction Worker	Recreational Child	Recreational Adult	Residential Child	Residential Adult	Industrial Worker	Construction Worker	Recreational Child	Recreational Adult	Residential Child	Residential Adult
Surface Soil (0 to <1 ft BLS)	Ingestion	5E-06 B	4E-06 B	3E-06 B	3E-06 B	5E-05 B	5E-05 B	5E-02 B	4E-01 B	3E-02 B	2E-02 B	1E+00 B	1E-01 B
	Dermal Contact	2E-06 B	1E-07 B	4E-07 B	4E-07 B	3E-06 B	3E-06 B	3E-02 B	2E-02 B	6E-03 B	6E-03 B	7E-02 B	4E-02 B
	Inhalation	1E-06 B	1E-07 B	2E-07 B	2E-07 B	3E-06 B	3E-06 B	1E-03 B	1E-03 B	2E-04 B	1E-04 B	6E-03 B	2E-03 B
	Subtotal	**8E-06 B**	**4E-06 B**	**4E-06 B**	**4E-06 B**	**5E-05 B**	**5E-05 B**	**8E-02 B**	**5E-01 B**	**4E-02 B**	**2E-02 B**	**1E+00 B**	**2E-01 B**
Subsurface Soil (1 to 10 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	NA	1E+00 B	NA	NA	3E+00 E	3E-01 B
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	2E-01 B	NA	NA	5E-01 B	3E-01 B
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**1E+00 B**	**NA**	**NA**	**4E+00 E**	**6E-01 B**
Sediment	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Surface Water	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Groundwater	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Rabbit	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Fish	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Surface Soil (0 to <1 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								8E-02 B	5E-01 B	4E-02 B	2E-02 B	1E+00 B	2E-01 B
Combined Cancer Risk:		8E-06 B	4E-06 B	4E-06 B	4E-06 B	5E-05 B	5E-05 B						
Subsurface Soil (1 to 10 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	1E+00 B	NA	NA	4E+00 E	6E-01 B
Combined Cancer Risk:		NA	NA	NA	NA	NA	NA						

NA - pathway not evaluated or all detected chemicals eliminated as COPCs
0E+00 - pathway evaluated but no risks could be calculated due to lack of EPA-approved toxicity values
B - HI $\leq$ 1 or ELCR $\leq 10^{-4}$
E - HI > 1 or ELCR > 10^{-4}

Table 6-54. Summary of Receptor Risks and Hazards for COCs at Study Area 20
Reasonable Maximum Exposure
Rifle Powder Finishing Area, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Soil	Rifle Powder Finishing Area	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
	Air	Rifle Powder Finishing Area	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
Subsurface Soil	Soil	Rifle Powder Finishing Area	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	2.34	--	0.157	2.50
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	2.34	--	0.157	2.50
	Air	Rifle Powder Finishing Area	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--

6.4.4.18 Study Area 21 – Red Water Ditch

The pathways evaluated at Study Area 21 are ingestion of and dermal contact with sediment and surface water, and ingestion of fish for recreational and residential receptors. The RME risk characterization summary for Study Area 21 is presented in **Table 6-55**, and COCs for each pathway and receptor are listed in **Tables 6-56** through **6-59**.

The maximum detected concentration of lead in sediment in Study Area 21 exceeds the 400 ppm screening level (EPA 1995c). Therefore, the EPA biokinetic uptake model was used to estimate blood lead levels in resident children. In using this model, the sediment is treated as if it were soil.

Recreational Scenario

The combined RME cancer risk for the integrated child or adult receptor is 5×10^{-4}, which exceeds the target cancer risk of 1×10^{-4}. The combined RME HIs of 5 for the child and 3 for the adult exceed the target HI of 1. Risks associated with fish ingestion are almost entirely responsible for exceedance of regulatory targets. Noncancer effects were segregated according to target organ. For recreational receptors ingesting fish, the medium TOHIs for the skin and eyes exceed the target HI. At Study Area 21, the following COCs in fish tissue were identified based on cancer and noncancer effects:

- arsenic: fish ingestion cancer risk = 5×10^{-4}
  fish ingestion HQ = 3 (child), 2 (adult)
- Aroclor-1254: fish ingestion cancer risk = 2×10^{-5}

Residential Scenario

The combined RME cancer risk for the integrated child or adult resident is 7×10^{-4}, which exceeds the target cancer risk of 1×10^{-4}. The combined RME HIs of 20 for the child and 3 for the adult exceed the target HI of 1. Risks associated with fish ingestion are almost entirely responsible for exceedance of regulatory targets. Noncancer effects were segregated according to target organ. For residents ingesting fish, the medium TOHIs for the skin and eyes exceed the target HI. The 95th percentile mean blood lead concentration in the resident child exposed to sediment is 6 µg/dL which is below the CDC target of 10 µg/dL. At Study Area 21, the following COCs in fish tissue were identified for residents based on cancer and noncancer effects:

- arsenic: fish ingestion cancer risk = 7×10^{-4}
  fish ingestion HQ = 10 (child), 2 (adult)
- Aroclor-1254: fish ingestion cancer risk = 3×10^{-5}
  fish ingestion HQ = 4 (child)

Table 6-55. RME Risk Characterization Summary for Study Area 21 (Current/Future and Future Land Uses)
Red Water Ditch, Alabama Army Ammunition Plant, Childersburg, Alabama

Medium	Exposure Route	Cancer Risk: Industrial Worker	Cancer Risk: Construction Worker	Cancer Risk: Recreational Child	Cancer Risk: Recreational Adult	Cancer Risk: Residential Child	Cancer Risk: Residential Adult	Noncancer HI: Industrial Worker	Noncancer HI: Construction Worker	Noncancer HI: Recreational Child	Noncancer HI: Recreational Adult	Noncancer HI: Residential Child	Noncancer HI: Residential Adult
Surface Soil (0 to <1 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Subsurface Soil (1 to 10 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sediment	Ingestion	NA	NA	2E-06 B	2E-06 B	7E-06 B	7E-06 B	NA	NA	6E-02 B	4E-02 B	7E-01 B	7E-02 B
	Dermal Contact	NA	NA	5E-07 B	5E-07 B	8E-07 B	8E-07 B	NA	NA	4E-02 B	3E-02 B	1E-01 B	6E-02 B
	Subtotal	NA	NA	2E-06 B	2E-06 B	8E-06 B	8E-06 B	NA	NA	1E-01 B	8E-02 B	8E-01 B	1E-01 B
Surface Water	Ingestion	NA	NA	2E-07 B	2E-07 B	5E-07 B	5E-07 B	NA	NA	9E-03 B	1E-03 B	5E-02 B	2E-03 B
	Dermal Contact	NA	NA	9E-08 B	9E-08 B	2E-07 B	2E-07 B	NA	NA	1E-02 B	1E-02 B	3E-02 B	2E-02 B
	Subtotal	NA	NA	3E-07 B	3E-07 B	7E-07 B	7E-07 B	NA	NA	2E-02 B	1E-02 B	9E-02 B	2E-02 B
Groundwater	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Rabbit	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fish	Ingestion	NA	NA	5E-04 E	5E-04 E	7E-04 E	7E-04 E	NA	NA	5E+00 E	3E+00 E	1E+01 E	3E+00 E
	Subtotal	NA	NA	5E-04 E	5E-04 E	7E-04 E	7E-04 E	NA	NA	5E+00 E	3E+00 E	1E+01 E	3E+00 E
Surface Soil (0 to <1 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	NA	5E+00 E	3E+00 E	2E+01 E	3E+00 E
Combined Cancer Risk:		NA	NA	5E-04 E	5E-04 E	7E-04 E	7E-04 E						
Subsurface Soil (1 to 10 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	NA	5E+00 E	3E+00 E	2E+01 E	3E+00 E
Combined Cancer Risk:		NA	NA	5E-04 E	5E-04 E	7E-04 E	7E-04 E						

NA - pathway not evaluated or all detected chemicals eliminated as COPCs
0E+00 - pathway evaluated but no risks could be calculated due to lack of EPA-approved toxicity values
B - HI ≤ 1 or ELCR ≤ 10^{-4}
E - HI > 1 or ELCR > 10^{-4}

Table 6-56. Summary of Receptor Risks and Hazards for COCs at Study Area 21
Reasonable Maximum Exposure
Red Water Ditch, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Recreational User
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water	Surface Water	Red Water Ditch	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Barium	--	--	--	--	Barium	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Zinc	--	--	--	--	Zinc	--	--	--	--	--
			Acetone	--	--	--	--	Acetone	--	--	--	--	--
			Carbon Disulfide	--	--	--	--	Carbon Disulfide	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
Sediment	Sediment	Red Water Ditch	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Barium	--	--	--	--	Barium	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Mercury	--	--	--	--	Mercury	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			2-Amino-4,6-Dinitrotoluene	--	--	--	--	2-Amino-4,6-Dinitrotoluene	--	--	--	--	--
			Benzo(a)pyrene	--	--	--	--	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	--	--	--	--	Benzo(b)fluoranthene	--	--	--	--	--
			Tetryl	--	--	--	--	Tetryl	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
Fish	Tissue	Red Water Ditch	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	0.000520	--	--	0.000520	Arsenic	skin	3.18	--	--	3.18
			Barium	--	--	--	--	Barium	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese (food)	--	--	--	--	--
			Selenium	--	--	--	--	Selenium	--	--	--	--	--
			Aroclor 1254	1.983E-05	--	--	1.983E-05	Aroclor 1254	eyes	1.36	--	--	1.36
			Heptachlor	--	--	--	--	Heptachlor	--	--	--	--	--
			beta-BHC	--	--	--	--	beta-BHC	--	--	--	--	--
			(Total)	0.000539	--	--	0.000539	(Total)	--	4.54	--	--	4.54

Table 6-57. Summary of Receptor Risks and Hazards for COCs at Study Area 21
Reasonable Maximum Exposure
Red Water Ditch, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Recreational User
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water	Surface Water	Red Water Ditch	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Barium	--	--	--	--	Barium	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Zinc	--	--	--	--	Zinc	--	--	--	--	--
			Acetone	--	--	--	--	Acetone	--	--	--	--	--
			Carbon Disulfide	--	--	--	--	Carbon Disulfide	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
Sediment	Sediment	Red Water Ditch	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Barium	--	--	--	--	Barium	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Mercury	--	--	--	--	Mercury	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			2-Amino-4,6-Dinitrotoluene	--	--	--	--	2-Amino-4,6-Dinitrotoluene	--	--	--	--	--
			Benzo(a)pyrene	--	--	--	--	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	--	--	--	--	Benzo(b)fluoranthene	--	--	--	--	--
			Tetryl	--	--	--	--	Tetryl	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
Fish	Tissue	Red Water Ditch	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	0.000520	--	--	0.000520	Arsenic	skin	2.04	--	--	2.04
			Barium	--	--	--	--	Barium	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese (food)	--	--	--	--	--
			Selenium	--	--	--	--	Selenium	--	--	--	--	--
			Aroclor 1254	1.983E-05	--	--	1.983E-05	Aroclor 1254	--	--	--	--	--
			Heptachlor	--	--	--	--	Heptachlor	--	--	--	--	--
			beta-BHC	--	--	--	--	beta-BHC	--	--	--	--	--
			(Total)	0.000539	--	--	0.000539	(Total)	--	2.04	--	--	2.04

Table 6-58. Summary of Receptor Risks and Hazards for COCs at Study Area 21
Reasonable Maximum Exposure
Red Water Ditch, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water	Surface Water	Red Water Ditch	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Barium	--	--	--	--	Barium	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Zinc	--	--	--	--	Zinc	--	--	--	--	--
			Acetone	--	--	--	--	Acetone	--	--	--	--	--
			Carbon Disulfide	--	--	--	--	Carbon Disulfide	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
Sediment	Sediment	Red Water Ditch	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Barium	--	--	--	--	Barium	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Mercury	--	--	--	--	Mercury	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			2-Amino-4,6-Dinitrotoluene	--	--	--	--	2-Amino-4,6-Dinitrotoluene	--	--	--	--	--
			Benzo(a)pyrene	--	--	--	--	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	--	--	--	--	Benzo(b)fluoranthene	--	--	--	--	--
			Tetryl	--	--	--	--	Tetryl	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
Fish	Tissue	Red Water Ditch	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	0.000683	--	--	0.000683	Arsenic	skin	9.53	--	--	9.53
			Barium	--	--	--	--	Barium	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese (food)	--	--	--	--	--
			Selenium	--	--	--	--	Selenium	--	--	--	--	--
			Aroclor 1254	2.607E-05	--	--	2.607E-05	Aroclor 1254	eyes	4.09	--	--	4.09
			Heptachlor	--	--	--	--	Heptachlor	--	--	--	--	--
			beta-BHC	--	--	--	--	beta-BHC	--	--	--	--	--
			(Total)	0.000709	--	--	0.000709	(Total)	--	14	--	--	14

Table 6-59. Summary of Receptor Risks and Hazards for COCs at Study Area 21
Reasonable Maximum Exposure
Red Water Ditch, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water	Surface Water	Red Water Ditch	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Barium	--	--	--	--	Barium	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Zinc	--	--	--	--	Zinc	--	--	--	--	--
			Acetone	--	--	--	--	Acetone	--	--	--	--	--
			Carbon Disulfide	--	--	--	--	Carbon Disulfide	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
Sediment	Sediment	Red Water Ditch	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Barium	--	--	--	--	Barium	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Mercury	--	--	--	--	Mercury	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			2-Amino-4,6-Dinitrotoluene	--	--	--	--	2-Amino-4,6-Dinitrotoluene	--	--	--	--	--
			Benzo(a)pyrene	--	--	--	--	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	--	--	--	--	Benzo(b)fluoranthene	--	--	--	--	--
			Tetryl	--	--	--	--	Tetryl	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
Fish	Tissue	Red Water Ditch	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	0.000683	--	--	0.000683	Arsenic	skin	2.04	--	--	2.04
			Barium	--	--	--	--	Barium	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese (food)	--	--	--	--	--
			Selenium	--	--	--	--	Selenium	--	--	--	--	--
			Aroclor 1254	2.607E-05	--	--	2.607E-05	Aroclor 1254	--	--	--	--	--
			Heptachlor	--	--	--	--	Heptachlor	--	--	--	--	--
			beta-BHC	--	--	--	--	beta-BHC	--	--	--	--	--
			(Total)	0.000709	--	--	0.000709	(Total)	--	2.04	--	--	2.04

Sediments from the Red Water Ditch have been removed and backfilled with clean material. Confirmatory samples were collected from a depth of greater than 1 foot below the surface of the sediment in the Red Water Ditch. Cancer risk and hazard estimates have been generated using the data for these sediment samples, and the results are presented in **Table 6-60**. The greatest RME HI is 0.9 for the resident child, and the greatest summed cancer risk is 1×10^{-7} for the resident. The risk estimates for each scenario are below the prescribed limits for cancer risk and noncarcinogenic hazards.

6.4.4.19 Study Area 22 -- Demolition Landfill

The pathways evaluated at Study Area 22 are soil ingestion, dermal contact, and inhalation of suspended soil particulates for all receptors. The RME risk characterization summary for Study Area 22 is presented in **Table 6-61**, and COCs for each pathway and receptor are listed in **Tables 6-62** through **6-64**.

The maximum detected concentration of lead in soil at Study Area 22 exceeds the 400 ppm screening level in surface and subsurface soils (EPA 1995c). Therefore, models were used to estimate blood lead levels in resident children, industrial workers, and construction workers.

Industrial Scenario

For industrial workers exposed to surface soil, the combined cancer risk under RME assumptions is 9×10^{-7}, which falls below the target cancer risk of 1×10^{-4}. The combined RME HI of 0.2 falls below the target HI of 1. The 95th percentile mean blood lead concentration in the fetus of the industrial worker is 12 µg/dL for surface soil exposure, which is above the CDC target of 10 µg/dL. Therefore, the following COC was identified for the industrial worker at Study Area 22:

- lead: surface soil, 95th percentile mean blood lead level = 12 µg/dL

Construction Scenario

For construction workers exposed to soil, the combined cancer risks under RME assumptions are 8×10^{-8} for surface soil exposure and 8×10^{-3} for subsurface soil exposure. The combined RME HIs are 0.4 for surface soil exposure and 5 for subsurface soil exposure. The combined subsurface soil cancer risk and hazard index exceed regulatory criteria. Noncancer effects were segregated according to target organ. However, the medium TOHIs for subsurface soil do not exceed the target HI of 1. Therefore, no COCs were identified based on noncancer effects. The 95th percentile mean blood lead concentration in the fetus of the construction worker is 18 µg/dL for surface soil exposure and 27 µg/dL for subsurface soil exposure. Both are above the CDC target of 10 µg/dL. The following COCs were identified for the construction worker at Study Area 22:

- arsenic: subsurface soil ingestion cancer risk = 8×10^{-6}

Table 6-60. RME Risk Characterization Summary for Study Area 21 - Subsurface Sediment (Current/Future and Future Land Uses)
Red Water Ditch, Alabama Army Ammunition Plant, Childersburg, Alabama

Medium	Exposure Route	Cancer Risk						Noncancer HI					
		Industrial Worker	Construction Worker	Recreational Child	Recreational Adult	Residential Child	Residential Adult	Industrial Worker	Construction Worker	Recreational Child	Recreational Adult	Residential Child	Residential Adult
Surface Soil (0 to <1 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Subsurface Soil (1 to 10 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sediment	Ingestion	NA	NA	2E-08 B	2E-08 B	9E-08 B	9E-08 B	NA	NA	7E-03 B	5E-03 B	8E-02 B	8E-03 B
	Dermal Contact	NA	NA	2E-08 B	2E-08 B	4E-08 B	4E-08 B	NA	NA	5E-03 B	5E-03 B	1E-02 B	9E-03 B
	Subtotal	NA	NA	5E-08 B	5E-08 B	1E-07 B	1E-07 B	NA	NA	1E-02 B	1E-02 B	9E-02 B	2E-02 B
Surface Water	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Groundwater	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Rabbit	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fish	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface Soil (0 to <1 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	NA	1E-02 B	1E-02 B	9E-02 B	2E-02 B
Combined Cancer Risk:		NA	NA	5E-08 B	5E-08 B	1E-07 B	1E-07 B						
Subsurface Soil (1 to 10 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	NA	1E-02 B	1E-02 B	9E-02 B	2E-02 B
Combined Cancer Risk:		NA	NA	5E-08 B	5E-08 B	1E-07 B	1E-07 B						

NA - pathway not evaluated or all detected chemicals eliminated as COPCs
0E+00 - pathway evaluated but no risks could be calculated due to lack of EPA-approved toxicity values
B - HI ≤ 1 or ELCR ≤ 10^{-4}
E - HI > 1 or ELCR > 10^{-4}

Table 6-61. RME Risk Characterization Summary for Study Area 22 (Current/Future and Future Land Uses) Demolition Landfill, Alabama Army Ammunition Plant, Childersburg, Alabama

Medium	Exposure Route	Cancer Risk: Industrial Worker	Cancer Risk: Construction Worker	Cancer Risk: Recreational Child	Cancer Risk: Recreational Adult	Cancer Risk: Residential Child	Cancer Risk: Residential Adult	Noncancer HI: Industrial Worker	Noncancer HI: Construction Worker	Noncancer HI: Recreational Child	Noncancer HI: Recreational Adult	Noncancer HI: Residential Child	Noncancer HI: Residential Adult
Surface Soil (0 to <1 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	4E-02 B	3E-01 B	2E-02 B	1E-02 B	9E-01 B	1E-01 B
	Dermal Contact	NA	NA	NA	NA	NA	NA	1E-01 B	9E-02 B	2E-02 B	2E-02 B	2E-01 B	1E-01 B
	Inhalation	9E-07 B	8E-08 B	1E-07 B	1E-07 B	2E-06 B	2E-06 B	5E-02 B	9E-03 B	1E-02 B	5E-03 B	2E-01 B	7E-02 B
	Subtotal	**9E-07 B**	**8E-08 B**	**1E-07 B**	**1E-07 B**	**2E-06 B**	**2E-06 B**	**2E-01 B**	**4E-01 B**	**5E-02 B**	**4E-02 B**	**1E+00 B**	**3E-01 B**
Subsurface Soil (1 to 10 ft BLS)	Ingestion	NA	5E-03 E	NA	NA	6E-02 E	6E-02 E	NA	4E+00 E	NA	NA	3E+01 E	4E+00 E
	Dermal Contact	NA	2E-03 E	NA	NA	5E-02 E	5E-02 E	NA	8E-01 B	NA	NA	9E+00 E	6E+00 E
	Inhalation	NA	3E-06 B	NA	NA	9E-05 B	9E-05 B	NA	6E-01	NA	NA	3E+00 E	8E-01 B
	Subtotal	**NA**	**8E-03 E**	**NA**	**NA**	**1E-01 E**	**1E-01 E**	**NA**	**5E+00 E**	**NA**	**NA**	**5E+01 E**	**1E+01 E**
Sediment	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Surface Water	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Groundwater	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Rabbit	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Fish	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Surface Soil (0 to <1 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								2E-01 B	4E-01 B	5E-02 B	4E-02 B	1E+00 B	3E-01 B
Combined Cancer Risk:		9E-07 B	8E-08 B	1E-07 B	1E-07 B	2E-06 B	2E-06 B						
Subsurface Soil (1 to 10 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	5E+00 E	NA	NA	5E+01 E	1E+01 E
Combined Cancer Risk:		NA	8E-03 E	NA	NA	1E-01 E	1E-01 E						

NA - pathway not evaluated or all detected chemicals eliminated as COPCs
0E+00 - pathway evaluated but no risks could be calculated due to lack of EPA-approved toxicity values
B - HI ≤ 1 or ELCR ≤ 10^{-4}
E - HI > 1 or ELCR > 10^{-4}

Table 6-62. Summary of Receptor Risks and Hazards for COCs at Study Area 22
Reasonable Maximum Exposure
Demolition Landfill, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Soil	Demolition Landfill	Barium	--	--	--	--	Barium	--	--	--	--	--
			Cadmium	--	--	--	--	Cadmium	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Copper	--	--	--	--	Copper	--	--	--	--	--
			Zinc	--	--	--	--	Zinc	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
	Air	Demolition Landfill	Barium	--	--	--	--	Barium	--	--	--	--	--
			Cadmium	--	--	--	--	Cadmium	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Copper	--	--	--	--	Copper	--	--	--	--	--
			Zinc	--	--	--	--	Zinc	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
Subsurface Soil	Soil	Demolition Landfill	Arsenic	7.786E-06	--	2.295E-07	8.015E-06	Arsenic	--	--	--	--	--
			Barium	--	--	--	--	Barium	--	--	--	--	--
			Cadmium	--	--	--	--	Cadmium	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Copper	--	--	--	--	Copper	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Mercury	--	--	--	--	Mercury	--	--	--	--	--
			Nickel	--	--	--	--	Nickel	--	--	--	--	--
			Zinc	--	--	--	--	Zinc	--	--	--	--	--
			Benzo(a)anthracene	8.816E-06	--	3.436E-06	1.225E-05	Benzo(a)anthracene	--	--	--	--	--
			Benzo(a)pyrene	9.796E-05	--	3.818E-05	0.000136	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	0.00490	--	0.00191	0.00681	Benzo(b)fluoranthene	--	--	--	--	--
			Benzo(g,h,i)perylene	--	--	--	--	Benzo(g,h,i)perylene	--	--	--	--	--
			Benzo(k)fluoranthene	6.857E-06	--	2.673E-06	9.530E-06	Benzo(k)fluoranthene	--	--	--	--	--
			Chrysene	--	--	--	--	Chrysene	--	--	--	--	--
			Dibenzo(a,h)anthracene	0.000294	--	0.000115	0.000408	Dibenzo(a,h)anthracene	--	--	--	--	--
			Dibenzofuran	--	--	--	--	Dibenzofuran	--	--	--	--	--
			Indeno(1,2,3-cd)pyrene	9.796E-05	--	3.818E-05	0.000136	Indeno(1,2,3-cd)pyrene	--	--	--	--	--
			Phenanthrene	--	--	--	--	Phenanthrene	--	--	--	--	--
			Pyrene	--	--	--	--	Pyrene	--	--	--	--	--
			(Total)	0.00541	--	0.00211	0.00752	(Total)	--	--	--	--	--
	Air	Demolition Landfill	Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Barium	--	--	--	--	Barium	--	--	--	--	--
			Cadmium	--	--	--	--	Cadmium	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Copper	--	--	--	--	Copper	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Mercury	--	--	--	--	Mercury	--	--	--	--	--
			Nickel	--	--	--	--	Nickel	--	--	--	--	--
			Zinc	--	--	--	--	Zinc	--	--	--	--	--
			Benzo(a)anthracene	--	--	--	--	Benzo(a)anthracene	--	--	--	--	--
			Benzo(a)pyrene	--	--	--	--	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	--	2.808E-06	--	2.808E-06	Benzo(b)fluoranthene	--	--	--	--	--
			Benzo(g,h,i)perylene	--	--	--	--	Benzo(g,h,i)perylene	--	--	--	--	--
			Benzo(k)fluoranthene	--	--	--	--	Benzo(k)fluoranthene	--	--	--	--	--
			Chrysene	--	--	--	--	Chrysene	--	--	--	--	--
			Dibenzo(a,h)anthracene	--	--	--	--	Dibenzo(a,h)anthracene	--	--	--	--	--
			Dibenzofuran	--	--	--	--	Dibenzofuran	--	--	--	--	--
			Indeno(1,2,3-cd)pyrene	--	--	--	--	Indeno(1,2,3-cd)pyrene	--	--	--	--	--
			Phenanthrene	--	--	--	--	Phenanthrene	--	--	--	--	--
			Pyrene	--	--	--	--	Pyrene	--	--	--	--	--
			(Total)	--	2.808E-06	--	2.808E-06	(Total)	--	--	--	--	--

Table 6-63. Summary of Receptor Risks and Hazards for COCs at Study Area 22
Reasonable Maximum Exposure
Demolition Landfill, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Soil	Demolition Landfill	Barium	--	--	--	--	Barium	--	--	--	--	--
			Cadmium	--	--	--	--	Cadmium	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Copper	--	--	--	--	Copper	--	--	--	--	--
			Zinc	--	--	--	--	Zinc	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
	Air	Demolition Landfill	Barium	--	--	--	--	Barium	--	--	--	--	--
			Cadmium	--	--	--	--	Cadmium	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Copper	--	--	--	--	Copper	--	--	--	--	--
			Zinc	--	--	--	--	Zinc	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
Subsurface Soil	Soil	Demolition Landfill	Arsenic	9.083E-05	--	5.413E-06	9.625E-05	Arsenic	skin	1.65	--	0.0404	1.69
			Barium	--	--	--	--	Barium	--	--	--	--	--
			Cadmium	--	--	--	--	Cadmium	kidney	0.235	--	0.236	0.472
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Copper	--	--	--	--	Copper	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	3.51	--	0.235	3.75
			Manganese	--	--	--	--	Manganese	CNS	0.711	--	0.179	0.889
			Mercury	--	--	--	--	Mercury	kidney	0.0895	--	0.0899	0.179
			Nickel	--	--	--	--	Nickel	--	--	--	--	--
			Zinc	--	--	--	--	Zinc	--	--	--	--	--
			Benzo(a)anthracene	0.000103	--	8.107E-05	0.000184	Benzo(a)anthracene	--	--	--	--	--
			Benzo(a)pyrene	0.00114	--	0.000901	0.00204	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	0.0555	--	0.0440	0.0996	Benzo(b)fluoranthene	--	21	--	6.91	28
			Benzo(g,h,i)perylene	--	--	--	--	Benzo(g,h,i)perylene	--	2.13	--	0.691	2.82
			Benzo(k)fluoranthene	8.000E-05	--	6.306E-05	0.000143	Benzo(k)fluoranthene	--	--	--	--	--
			Chrysene	4.571E-06	--	3.603E-06	8.175E-06	Chrysene	--	--	--	--	--
			Dibenzo(a,h)anthracene	0.00343	--	0.00270	0.00613	Dibenzo(a,h)anthracene	--	--	--	--	--
			Dibenzofuran	--	--	--	--	Dibenzofuran	--	--	--	--	--
			Indeno(1,2,3-cd)pyrene	0.00114	--	0.000901	0.00204	Indeno(1,2,3-cd)pyrene	--	--	--	--	--
			Phenanthrene	--	--	--	--	Phenanthrene	--	--	--	--	--
			Pyrene	--	--	--	--	Pyrene	kidney	0.426	--	0.138	0.564
			(Total)	0.0615	--	0.0487	0.110	(Total)	--	30	--	8.52	39
	Air	Demolition Landfill	Arsenic	--	2.768E-06	--	2.768E-06	Arsenic	--	--	--	--	--
			Barium	--	--	--	--	Barium	--	--	--	--	--
			Cadmium	--	--	--	--	Cadmium	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	4.874E-06	--	4.874E-06	Chromium, hexavalent (assumed)	--	--	--	--	--
			Copper	--	--	--	--	Copper	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	--	2.42	--	2.42
			Mercury	--	--	--	--	Mercury	--	--	--	--	--
			Nickel	--	--	--	--	Nickel	--	--	--	--	--
			Zinc	--	--	--	--	Zinc	--	--	--	--	--
			Benzo(a)anthracene	--	--	--	--	Benzo(a)anthracene	--	--	--	--	--
			Benzo(a)pyrene	--	1.474E-06	--	1.474E-06	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	--	7.371E-05	--	7.371E-05	Benzo(b)fluoranthene	--	--	--	--	--
			Benzo(g,h,i)perylene	--	--	--	--	Benzo(g,h,i)perylene	--	--	--	--	--
			Benzo(k)fluoranthene	--	--	--	--	Benzo(k)fluoranthene	--	--	--	--	--
			Chrysene	--	--	--	--	Chrysene	--	--	--	--	--
			Dibenzo(a,h)anthracene	--	4.423E-06	--	4.423E-06	Dibenzo(a,h)anthracene	--	--	--	--	--
			Dibenzofuran	--	--	--	--	Dibenzofuran	--	--	--	--	--
			Indeno(1,2,3-cd)pyrene	--	1.474E-06	--	1.474E-06	Indeno(1,2,3-cd)pyrene	--	--	--	--	--
			Phenanthrene	--	--	--	--	Phenanthrene	--	--	--	--	--
			Pyrene	--	--	--	--	Pyrene	--	--	--	--	--
			(Total)	--	8.872E-05	--	8.872E-05	(Total)	--	--	2.42	--	2.42

Table 6-64. Summary of Receptor Risks and Hazards for COCs at Study Area 22
Reasonable Maximum Exposure
Demolition Landfill, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Soil	Demolition Landfill	Barium	--	--	--	--	Barium	--	--	--	--	--
			Cadmium	--	--	--	--	Cadmium	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Copper	--	--	--	--	Copper	--	--	--	--	--
			Zinc	--	--	--	--	Zinc	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
	Air	Demolition Landfill	Barium	--	--	--	--	Barium	--	--	--	--	--
			Cadmium	--	--	--	--	Cadmium	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Copper	--	--	--	--	Copper	--	--	--	--	--
			Zinc	--	--	--	--	Zinc	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
Subsurface Soil	Soil	Demolition Landfill	Arsenic	9.083E-05	--	5.413E-06	9.625E-05	Arsenic	--	--	--	--	--
			Barium	--	--	--	--	Barium	--	--	--	--	--
			Cadmium	--	--	--	--	Cadmium	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Copper	--	--	--	--	Copper	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Mercury	--	--	--	--	Mercury	--	--	--	--	--
			Nickel	--	--	--	--	Nickel	--	--	--	--	--
			Zinc	--	--	--	--	Zinc	--	--	--	--	--
			Benzo(a)anthracene	0.000103	--	8.107E-05	0.000184	Benzo(a)anthracene	--	--	--	--	--
			Benzo(a)pyrene	0.00114	--	0.000901	0.00204	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	0.0555	--	0.0440	0.0996	Benzo(b)fluoranthene	--	2.28	--	4.27	6.55
			Benzo(g,h,i)perylene	--	--	--	--	Benzo(g,h,i)perylene	--	--	--	--	--
			Benzo(k)fluoranthene	8.000E-05	--	6.306E-05	0.000143	Benzo(k)fluoranthene	--	--	--	--	--
			Chrysene	4.571E-06	--	3.603E-06	8.175E-06	Chrysene	--	--	--	--	--
			Dibenzo(a,h)anthracene	0.00343	--	0.00270	0.00613	Dibenzo(a,h)anthracene	--	--	--	--	--
			Dibenzofuran	--	--	--	--	Dibenzofuran	--	--	--	--	--
			Indeno(1,2,3-cd)pyrene	0.00114	--	0.000901	0.00204	Indeno(1,2,3-cd)pyrene	--	--	--	--	--
			Phenanthrene	--	--	--	--	Phenanthrene	--	--	--	--	--
			Pyrene	--	--	--	--	Pyrene	--	--	--	--	--
			(Total)	0.0615	--	0.0487	0.110	(Total)	--	2.28	--	4.27	6.55
	Air	Demolition Landfill	Arsenic	--	2.768E-06	--	2.768E-06	Arsenic	--	--	--	--	--
			Barium	--	--	--	--	Barium	--	--	--	--	--
			Cadmium	--	--	--	--	Cadmium	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	4.874E-06	--	4.874E-06	Chromium, hexavalent (assumed)	--	--	--	--	--
			Copper	--	--	--	--	Copper	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Mercury	--	--	--	--	Mercury	--	--	--	--	--
			Nickel	--	--	--	--	Nickel	--	--	--	--	--
			Zinc	--	--	--	--	Zinc	--	--	--	--	--
			Benzo(a)anthracene	--	--	--	--	Benzo(a)anthracene	--	--	--	--	--
			Benzo(a)pyrene	--	1.474E-06	--	1.474E-06	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	--	7.371E-05	--	7.371E-05	Benzo(b)fluoranthene	--	--	--	--	--
			Benzo(g,h,i)perylene	--	--	--	--	Benzo(g,h,i)perylene	--	--	--	--	--
			Benzo(k)fluoranthene	--	--	--	--	Benzo(k)fluoranthene	--	--	--	--	--
			Chrysene	--	--	--	--	Chrysene	--	--	--	--	--
			Dibenzo(a,h)anthracene	--	4.423E-06	--	4.423E-06	Dibenzo(a,h)anthracene	--	--	--	--	--
			Dibenzofuran	--	--	--	--	Dibenzofuran	--	--	--	--	--
			Indeno(1,2,3-cd)pyrene	--	1.474E-06	--	1.474E-06	Indeno(1,2,3-cd)pyrene	--	--	--	--	--
			Phenanthrene	--	--	--	--	Phenanthrene	--	--	--	--	--
			Pyrene	--	--	--	--	Pyrene	--	--	--	--	--
			(Total)	--	8.872E-05	--	8.872E-05	(Total)	--	--	--	--	--

- lead: surface soil, 95th percentile mean blood lead level = 18 μg/dL
  subsurface soil, 95th percentile mean blood lead level = 27 μg/dL
- benzo(a)anthracene: subsurface soil ingestion cancer risk = 9×10^{-6}
  subsurface soil dermal contact cancer risk = 3×10^{-6}
- benzo(a)pyrene: subsurface soil ingestion cancer risk = 1×10^{-4}
  subsurface soil dermal contact cancer risk = 4×10^{-5}
- benzo(b)fluoranthene: subsurface soil ingestion cancer risk = 5×10^{-3}
  subsurface soil dermal contact cancer risk = 2×10^{-3}
  subsurface soil inhalation cancer risk = 3×10^{-6}
- benzo(k)fluoranthene: subsurface soil ingestion cancer risk = 7×10^{-6}
  subsurface soil dermal contact cancer risk = 3×10^{-6}
- dibenzo(a,h)anthracene: subsurface soil ingestion cancer risk = 3×10^{-4}
  subsurface soil dermal contact cancer risk = 1×10^{-4}
- indeno(1,2,3-cd)pyrene: subsurface soil ingestion cancer risk = 1×10^{-4}
  subsurface soil dermal contact cancer risk = 4×10^{-5}

Recreational Scenario

For recreational receptors exposed to surface soil, the combined RME cancer risk for the integrated child or adult receptor is 1×10^{-7}, which is below the target cancer risk of 1×10^{-4}. The combined RME HIs of 0.05 for the child and 0.04 for the adult fall below the target HI of 1. Therefore, no COCs were identified for recreational receptors at Study Area 22.

Residential Scenario

The combined RME cancer risks for the integrated child or adult resident are 2×10^{-6} for exposure to surface soil and 1×10^{-1} for exposure to subsurface soil. For noncancer effects, the combined RME HIs are 1 and 50 (surface and subsurface soil exposures, respectively for the child), and 0.3 and 10 (surface and subsurface soil exposures, respectively for the adult). The combined subsurface soil cancer risk and hazard index exceed regulatory criteria. Noncancer effects were segregated according to target organ. In subsurface soils, the medium TOHI for the central nervous system exceeds the target HI for the child and the adult, and the medium TOHI for the skin exceeds the target HI only for the child. The 95th percentile mean blood lead concentration in the resident child is 35 μg/dL for exposure to surface soil and 49 μg/dL for exposure to subsurface soil, both of

which are above the CDC target of 10 μg/dL. The following COCs were identified for residents at Study Area 22:

- arsenic: subsurface soil ingestion cancer risk = 9×10^{-5}
  subsurface soil ingestion HQ = 2 (child)
  subsurface soil dermal contact cancer risk = 5×10^{-6}
  subsurface soil inhalation cancer risk = 3×10^{-6}
- chromium, hexavalent: subsurface soil inhalation cancer risk = 5×10^{-6}
- iron: subsurface soil ingestion HQ = 4 (child)
  subsurface soil dermal contact HQ = 0.2 (child)
- lead: surface soil, 95th percentile mean blood lead level = 35 μg/dL
  subsurface soil, 95th percentile mean blood lead level = 49 μg/dL
- manganese: subsurface soil ingestion HQ = 0.7 (child)
  subsurface soil dermal contact HQ = 0.2 (child)
  subsurface soil inhalation HQ = 2 (child)
- benzo(a)anthracene: subsurface soil ingestion cancer risk = 1×10^{-4}
  subsurface soil dermal contact cancer risk = 8×10^{-5}
- benzo(a)pyrene: subsurface soil ingestion cancer risk = 1×10^{-3}
  subsurface soil dermal contact cancer risk = 9×10^{-4}
  subsurface soil inhalation cancer risk = 1×10^{-6}
- benzo(b)fluoranthene: subsurface soil ingestion cancer risk = 6×10^{-2}
  subsurface soil ingestion HQ = 21 (child), 2 (adult)
  subsurface soil dermal contact cancer risk = 4×10^{-2}
  subsurface soil dermal contact HQ = 7 (child), 4 (adult)
  subsurface soil inhalation cancer risk = 7×10^{-5}
- benzo(g,h,i)perylene: subsurface soil ingestion HQ = 2 (child)
  subsurface soil dermal contact HQ = 0.7 (child)
- benzo(k)fluoranthene: subsurface soil ingestion cancer risk = 8×10^{-5}
  subsurface soil dermal contact cancer risk = 6×10^{-5}
- chrysene: subsurface soil ingestion cancer risk = 5×10^{-6}
  subsurface soil dermal contact cancer risk = 4×10^{-6}

- dibenzo(a,h)anthracene: subsurface soil ingestion cancer risk = 3×10^{-3}
  subsurface soil dermal contact cancer risk = 3×10^{-3}
  subsurface soil inhalation cancer risk = 4×10^{-6}

- indeno(1,2,3-cd)pyrene: subsurface soil ingestion cancer risk = 1×10^{-3}
  subsurface soil dermal contact cancer risk = 9×10^{-4}
  subsurface soil inhalation cancer risk = 1×10^{-6}

6.4.4.20 Study Area 25 – Storage Battery/Demolition Debris

The pathways evaluated at Study Area 25 are soil ingestion, dermal contact, and inhalation of suspended soil particulates for all receptors. The RME risk characterization summary for Study Area 25 is presented in **Table 6-65**, and COCs for each pathway and receptor are listed in **Table 6-66**.

Industrial Scenario

For industrial workers exposed to surface soil, the combined cancer risk under RME assumptions is 8×10^{-6}, which falls below the target cancer risk of 1×10^{-4}. The combined RME HI of 0.3 falls below the target HI of 1. Therefore, no COCs were identified for the industrial worker at Study Area 25.

Construction Scenario

For construction workers exposed to soil, the combined cancer risks under RME assumptions are 4×10^{-6} for surface soil exposure. Cancer risks were not quantified for subsurface soil exposure because none of the COPCs has a toxicity value for cancer effects. The combined RME HIs are 1 for surface soil exposure and 0.5 for subsurface soil exposure. The former equals but does not exceed the target HI of 1. No COCs were identified for the construction worker at Study Area 25.

Recreational Scenario

For recreational receptors exposed to surface soil, the combined RME cancer risk for the integrated child or adult receptor is 4×10^{-6}, which is below the target cancer risk of 1×10^{-4}. The combined RME HIs of 0.1 for the child and 0.08 for the adult fall below the target HI of 1. Therefore, no COCs were identified for recreational receptors at Study Area 25.

Residential Scenario

The combined RME cancer risk for the integrated child or adult resident is 5×10^{-5} for exposure to surface soil, which is below the target cancer risk of 1×10^{-4}. Cancer risks were not

Table 6-65. RME Risk Characterization Summary for Study Area 25 (Current/Future and Future Land Uses) Storage Battery/Demolition Debris, Alabama Army Ammunition Plant, Childersburg, Alabama

Medium	Exposure Route	Cancer Risk: Industrial Worker	Cancer Risk: Construction Worker	Cancer Risk: Recreational Child	Cancer Risk: Recreational Adult	Cancer Risk: Residential Child	Cancer Risk: Residential Adult	Noncancer HI: Industrial Worker	Noncancer HI: Construction Worker	Noncancer HI: Recreational Child	Noncancer HI: Recreational Adult	Noncancer HI: Residential Child	Noncancer HI: Residential Adult
Surface Soil (0 to <1 ft BLS)	Ingestion	5E-06 B	4E-06 B	3E-06 B	3E-06 B	5E-05 B	5E-05 B	1E-01 B	1E+00 B	8E-02 B	5E-02 B	3E+00 E	4E-01 B
	Dermal Contact	1E-06 B	1E-07 B	4E-07 B	4E-07 B	3E-06 B	3E-06 B	2E-01 B	1E-01 B	3E-02 B	3E-02 B	3E-01 B	2E-01 B
	Inhalation	1E-06 B	1E-07 B	2E-07 B	2E-07 B	3E-06 B	3E-06 B	1E-03 B	1E-03 B	2E-04 B	9E-05 B	5E-03 B	1E-03 B
	Subtotal	**8E-06 B**	**4E-06 B**	**4E-06 B**	**4E-06 B**	**5E-05 B**	**5E-05 B**	**3E-01 B**	**1E+00 B**	**1E-01 B**	**8E-02 B**	**4E+00 E**	**6E-01 B**
Subsurface Soil (1 to 10 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	NA	2E-01 B	NA	NA	4E-01 B	4E-02 B
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	5E-02 B	NA	NA	1E-01 B	6E-02 B
	Inhalation	NA	NA	NA	NA	NA	NA	NA	3E-01	NA	NA	1E+00 B	4E-01 B
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**5E-01 B**	**NA**	**NA**	**2E+00 E**	**5E-01 B**
Sediment	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Surface Water	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Groundwater	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Rabbit	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Fish	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Surface Soil (0 to <1 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								3E-01 B	1E+00 B	1E-01 B	8E-02 B	4E+00 E	6E-01 B
Combined Cancer Risk:		8E-06 B	4E-06 B	4E-06 B	4E-06 B	5E-05 B	5E-05 B						
Subsurface Soil (1 to 10 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	5E-01 B	NA	NA	2E+00 E	5E-01 B
Combined Cancer Risk:		NA	NA	NA	NA	NA	NA						

NA - *pathway not evaluated or all detected chemicals eliminated as COPCs*
0E+00 - pathway evaluated but no risks could be calculated due to lack of EPA-approved toxicity values
B - HI ≤ 1 or ELCR ≤ 10^{-4}
E - HI > 1 or ELCR > 10^{-4}

Table 6-66. Summary of Receptor Risks and Hazards for COCs at Study Area 25
Reasonable Maximum Exposure
Storage Battery/Demolition Debris, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Soil	Storage Battery/Demolition Debris	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	1.96	--	0.131	2.09
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	1.96	--	0.131	2.09
	Air	Storage Battery/Demolition Debris	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
Subsurface Soil	Soil	Storage Battery/Demolition Debris	Manganese	--	--	--	--	Manganese	CNS	0.417	--	0.105	0.522
			(Total)	--	--	--	--	(Total)	--	0.417	--	0.105	0.522
	Air	Storage Battery/Demolition Debris	Manganese	--	--	--	--	Manganese	CNS	--	1.42	--	1.42
			(Total)	--	--	--	--	(Total)	--	--	1.42	--	1.42

quantified for subsurface soil exposure because none of the COPCs has a toxicity value for cancer effects. For noncancer effects, the combined RME HIs are 4 and 2 (surface and subsurface soil exposures, respectively for the child) and 0.6 and 0.5 (both surface and subsurface soil exposures for the adult). Noncancer effects were segregated according to target organ. For the resident child and adult, the medium TOHIs for the central nervous system exceed the target HI in subsurface soils. The following COCs were identified for residents at Study Area 25 based on noncancer effects:

- iron: surface soil ingestion HQ = 2 (child)
  surface soil dermal contact HQ = 0.1 (child)
- manganese: subsurface soil ingestion HQ = 0.4 (child)
  subsurface soil dermal contact HQ = 0.1 (child)
  subsurface soil inhalation HQ = 1 (child)

6.4.4.21 Study Area 26 – Crossover Ditch

The pathways evaluated at Study Area 26 are ingestion of and dermal contact with sediment and surface water, and ingestion of fish for recreational and residential receptors. The RME risk characterization summary for Study Area 26 is presented in **Table 6-67**, and COCs for each pathway and receptor are listed in **Tables 6-68**.

Recreational Scenario

The combined RME cancer risk for the integrated child or adult receptor is 4×10^{-6}, which falls below the target cancer risk of 1×10^{-4}. The combined RME HIs of 0.8 for the child and 1 for the adult equal but do not exceed the target HI of 1. Therefore, no COCs were identified for recreational receptors at Study Area 26.

Residential Scenario

The combined RME cancer risk for the integrated child or adult resident is 1×10^{-5}, which falls below the target cancer risk of 1×10^{-4}. The combined RME HIs of 3 for the child and 0.6 for the adult exceed the target HI of 1. Risks associated with fish ingestion are responsible for the majority of the risk. Noncancer effects were segregated according to target organ. For residents ingesting fish, the medium TOHI for the kidneys exceeds the target HI. At Study Area 26, the following COC in fish tissue was identified for residents based on noncancer effects:

- *mercury:* *fish ingestion HQ = 2 (child)*

Table 6-67. RME Risk Characterization Summary for Study Area 26 (Current/Future and Future Land Uses) Crossover Ditch, Alabama Army Ammunition Plant, Childersburg, Alabama

Medium	Exposure Route	Cancer Risk: Industrial Worker	Cancer Risk: Construction Worker	Cancer Risk: Recreational Child	Cancer Risk: Recreational Adult	Cancer Risk: Residential Child	Cancer Risk: Residential Adult	Noncancer HI: Industrial Worker	Noncancer HI: Construction Worker	Noncancer HI: Recreational Child	Noncancer HI: Recreational Adult	Noncancer HI: Residential Child	Noncancer HI: Residential Adult
Surface Soil (0 to <1 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Subsurface Soil (1 to 10 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sediment	Ingestion	NA	NA	3E-06 B	3E-06 B	1E-05 B	1E-05 B	NA	NA	6E-02 B	4E-02 B	6E-01 B	7E-02 B
	Dermal Contact	NA	NA	4E-07 B	4E-07 B	6E-07 B	6E-07 B	NA	NA	3E-02 B	2E-02 B	7E-02 B	4E-02 B
	Subtotal	NA	NA	3E-06 B	3E-06 B	1E-05 B	1E-05 B	NA	NA	9E-02 B	6E-02 B	7E-01 B	1E-01 B
Surface Water	Ingestion	NA	NA	1E-07 B	1E-07 B	3E-07 B	3E-07 B	NA	NA	1E-02 B	2E-03 B	8E-02 B	3E-03 B
	Dermal Contact	NA	NA	6E-08 B	6E-08 B	1E-07 B	1E-07 B	NA	NA	2E-02 B	2E-02 B	6E-02 B	4E-02 B
	Subtotal	NA	NA	2E-07 B	2E-07 B	5E-07 B	5E-07 B	NA	NA	4E-02 B	2E-02 B	1E-01 B	4E-02 B
Groundwater	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Rabbit	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fish	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	7E-01 B	4E-01 B	2E+00 E	4E-01 B
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	7E-01 B	4E-01 B	2E+00 E	4E-01 B
Surface Soil (0 to <1 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	NA	8E-01 B	5E-01 B	3E+00 E	6E-01 B
Combined Cancer Risk:		NA	NA	4E-06 B	4E-06 B	1E-05 B	1E-05 B						
Subsurface Soil (1 to 10 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	NA	8E-01 B	5E-01 B	3E+00 E	6E-01 B
Combined Cancer Risk:		NA	NA	4E-06 B	4E-06 B	1E-05 B	1E-05 B						

NA - pathway not evaluated or all detected chemicals eliminated as COPCs
0E+00 - pathway evaluated but no risks could be calculated due to lack of EPA-approved toxicity values
B - HI ≤ 1 or ELCR ≤ 10^{-4}
E - HI > 1 or ELCR > 10^{-4}

Table 6-68. Summary of Receptor Risks and Hazards for COCs at Study Area 26
Reasonable Maximum Exposure
Crossover Ditch, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water	Surface Water	Crossover Ditch	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Barium	--	--	--	--	Barium	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			2,4-Dinitrotoluene	--	--	--	--	2,4-Dinitrotoluene	--	--	--	--	--
			Carbon Disulfide	--	--	--	--	Carbon Disulfide	--	--	--	--	--
			Carbon Tetrachloride	--	--	--	--	Carbon Tetrachloride	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
Sediment	Sediment	Crossover Ditch	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Barium	--	--	--	--	Barium	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Thallium	--	--	--	--	Thallium	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
Fish	Tissue	Crossover Ditch	Mercury	--	--	--	--	Mercury	kidney	1.95	--	--	1.95
			Selenium	--	--	--	--	Selenium	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	1.95	--	--	1.95

6.4.4.22 Study Area 27 – Beaver Pond Drainage System

The pathways evaluated at Study Area 27 are ingestion of and dermal contact with sediment and surface water, and ingestion of fish for recreational and residential receptors. The RME risk characterization summary for Study Area 27 is presented in **Table 6-69**.

Recreational Scenario

The combined RME cancer risk for the integrated child or adult receptor is 2×10^{-6}, which falls below the target cancer risk of 1×10^{-4}. The combined RME HIs of 0.4 for the child and 0.2 for the adult fall below the target HI of 1. Therefore, no COCs were identified for recreational receptors at Study Area 27.

Residential Scenario

The combined RME cancer risk for the integrated child or adult resident is 5×10^{-6}, which falls below the target cancer risk of 1×10^{-4}. The combined RME HIs of 1 for the resident child equals but does not exceed the target HI of 1 (HI for the adult is 0.3). No COCs were identified for residents at Study Area 27.

6.4.4.23 Building 6 – Coke Oven

The pathways evaluated at Building 6 are soil ingestion, dermal contact, and inhalation of suspended soil particulates for all receptors. The RME risk characterization summary for Building 6 is presented in **Table 6-70**, and COCs are listed in **Table 6-71**.

Industrial Scenario

For industrial workers exposed to surface soil, the combined cancer risk under RME assumptions is 8×10^{-6}, which falls below the target cancer risk of 1×10^{-4}. The combined RME HI of 0.2 falls below the target HI of 1. Therefore, no COCs were identified for the industrial worker at Building 6.

Construction Scenario

For construction workers exposed to soil, the combined cancer risks under RME assumptions are 4×10^{-6} for surface soil exposure and 1×10^{-5} for subsurface soil exposure. The combined RME HIs are 1 for surface soil exposure and 2 for subsurface soil exposure. The latter exceeds the target HI of 1. Noncancer effects were segregated according to target organ. The medium TOHIs for subsurface soil do not exceed the target HI. Therefore, no COCs were identified for the construction worker at Building 6.

Table 6-69. RME Risk Characterization Summary for Study Area 27 (Current/Future and Future Land Uses)
Beaver Pond Drainage System, Alabama Army Ammunition Plant, Childersburg, Alabama

Medium	Exposure Route	Cancer Risk: Industrial Worker	Cancer Risk: Construction Worker	Cancer Risk: Recreational Child	Cancer Risk: Recreational Adult	Cancer Risk: Residential Child	Cancer Risk: Residential Adult	Noncancer HI: Industrial Worker	Noncancer HI: Construction Worker	Noncancer HI: Recreational Child	Noncancer HI: Recreational Adult	Noncancer HI: Residential Child	Noncancer HI: Residential Adult
Surface Soil (0 to <1 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Subsurface Soil (1 to 10 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sediment	Ingestion	NA	NA	1E-06 B	1E-06 B	4E-06 B	4E-06 B	NA	NA	4E-02 B	2E-02 B	4E-01 B	4E-02 B
	Dermal Contact	NA	NA	2E-07 B	2E-07 B	4E-07 B	4E-07 B	NA	NA	2E-02 B	2E-02 B	5E-02 B	3E-02 B
	Subtotal	NA	NA	1E-06 B	1E-06 B	5E-06 B	5E-06 B	NA	NA	6E-02 B	4E-02 B	5E-01 B	7E-02 B
Surface Water	Ingestion	NA	NA	1E-07 B	1E-07 B	3E-07 B	3E-07 B	NA	NA	2E-02 B	3E-03 B	1E-01 B	5E-03 B
	Dermal Contact	NA	NA	8E-08 B	8E-08 B	1E-07 B	1E-07 B	NA	NA	4E-02 B	4E-02 B	1E-01 B	7E-02 B
	Subtotal	NA	NA	2E-07 B	2E-07 B	5E-07 B	5E-07 B	NA	NA	7E-02 B	4E-02 B	2E-01 B	7E-02 B
Groundwater	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Rabbit	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fish	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	2E-01 B	2E-01 B	7E-01 B	2E-01 B
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	2E-01 B	2E-01 B	7E-01 B	2E-01 B
Surface Soil (0 to <1 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	NA	4E-01 B	2E-01 B	1E+00 B	3E-01 B
Combined Cancer Risk:		NA	NA	2E-06 B	2E-06 B	5E-06 B	5E-06 B						
Subsurface Soil (1 to 10 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	NA	4E-01 B	2E-01 B	1E+00 B	3E-01 B
Combined Cancer Risk:		NA	NA	2E-06 B	2E-06 B	5E-06 B	5E-06 B						

NA - pathway not evaluated or all detected chemicals eliminated as COPCs
0E+00 - pathway evaluated but no risks could be calculated due to lack of EPA-approved toxicity values
B - HI ≤ 1 or ELCR ≤ 10^{-4}
E - HI > 1 or ELCR > 10^{-4}

Table 6-70. RME Risk Characterization Summary for Study Area B6 (Current/Future and Future Land Uses) Building 6 - Coke Oven, Alabama Army Ammunition Plant, Childersburg, Alabama

Medium	Exposure Route	Cancer Risk: Industrial Worker	Cancer Risk: Construction Worker	Cancer Risk: Recreational Child	Cancer Risk: Recreational Adult	Cancer Risk: Residential Child	Cancer Risk: Residential Adult	Noncancer HI: Industrial Worker	Noncancer HI: Construction Worker	Noncancer HI: Recreational Child	Noncancer HI: Recreational Adult	Noncancer HI: Residential Child	Noncancer HI: Residential Adult
Surface Soil (0 to <1 ft BLS)	Ingestion	6E-06 B	4E-06 B	4E-06 B	4E-06 B	5E-05 B	5E-05 B	1E-01 B	1E+00 B	7E-02 B	5E-02 B	3E+00 E	3E-01 B
	Dermal Contact	2E-06 B	1E-07 B	4E-07 B	4E-07 B	3E-06 B	3E-06 B	8E-02 B	8E-02 B	2E-02 B	2E-02 B	2E-01 B	1E-01 B
	Inhalation	6E-07 B	6E-08 B	1E-07 B	1E-07 B	2E-06 B	2E-06 B	NA	NA	NA	NA	NA	NA
	Subtotal	**8E-06 B**	**4E-06 B**	**4E-06 B**	**4E-06 B**	**5E-05 B**	**5E-05 B**	**2E-01 B**	**1E+00 B**	**9E-02 B**	**6E-02 B**	**3E+00 E**	**4E-01 B**
Subsurface Soil (1 to 10 ft BLS)	Ingestion	NA	9E-06 B	NA	NA	1E-04 B	1E-04 B	NA	2E+00 E	NA	NA	5E+00 E	6E-01 B
	Dermal Contact	NA	3E-07 B	NA	NA	6E-06 B	6E-06 B	NA	2E-01 B	NA	NA	3E-01 B	2E-01 B
	Inhalation	NA	1E-07 B	NA	NA	3E-06 B	3E-06 B	NA	3E-01	NA	NA	1E+00 B	4E-01 B
	Subtotal	**NA**	**1E-05 B**	**NA**	**NA**	**1E-04 B**	**1E-04 B**	**NA**	**2E+00 E**	**NA**	**NA**	**7E+00 E**	**1E+00 B**
Sediment	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface Water	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Groundwater	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Rabbit	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fish	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface Soil (0 to <1 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								2E-01 B	1E+00 B	9E-02 B	6E-02 B	3E+00 E	4E-01 B
Combined Cancer Risk:		8E-06 B	4E-06 B	4E-06 B	4E-06 B	5E-05 B	5E-05 B						
Subsurface Soil (1 to 10 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	2E+00 E	NA	NA	7E+00 E	1E+00 B
Combined Cancer Risk:		NA	1E-05 B	NA	NA	1E-04 B	1E-04 B						

NA - pathway not evaluated or all detected chemicals eliminated as COPCs
0E+00 - pathway evaluated but no risks could be calculated due to lack of EPA-approved toxicity values
B - HI ≤ 1 or ELCR ≤ 10^{-4}
E - HI > 1 or ELCR > 10^{-4}

Table 6-71. Summary of Receptor Risks and Hazards for COCs at Study Area B6
Reasonable Maximum Exposure
Building 6 - Coke Oven, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Soil	Building 6 - Coke Oven	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	1.78	--	0.119	1.90
			(Total)	--	--	--	--	(Total)	--	1.78	--	0.119	1.90
	Air	Building 6 - Coke Oven	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
Subsurface Soil	Soil	Building 6 - Coke Oven	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	skin	1.96	--	0.0481	2.01
			Iron	--	--	--	--	Iron	--	2.43	--	0.163	2.59
			Manganese	--	--	--	--	Manganese	CNS	0.378	--	0.0950	0.473
			(Total)	--	--	--	--	(Total)	--	4.77	--	0.306	5.07
	Air	Building 6 - Coke Oven	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	--	1.29	--	1.29
			(Total)	--	--	--	--	(Total)	--	--	1.29	--	1.29

Recreational Scenario

For recreational receptors exposed to surface soil, the combined RME cancer risk for the integrated child or adult receptor is 4×10^{-6}, which is below the target cancer risk of 1×10^{-4}. The combined RME HIs of 0.09 for the child and 0.06 for the adult fall below the target HI of 1. Therefore, no COCs were identified for recreational receptors at Building 6.

Residential Scenario

The combined RME cancer risks for the integrated child or adult resident are 5×10^{-5} for exposure to surface soil and 1×10^{-4} for exposure to subsurface soil. Both are at or below the target cancer risk of 1×10^{-4}. For noncancer effects, the combined RME HIs are 3 and 7 (surface and subsurface soil exposures, respectively for the child) and 0.4 and 1 (surface and subsurface soil exposures, respectively for the adult). Noncancer effects were segregated according to target organ. For the resident child, the medium TOHIs for the central nervous system and skin exceed the target HI in subsurface soils. The following COCs were identified for residents at Building 6 based on noncancer effects:

- arsenic: subsurface soil ingestion HQ = 2 (child)
- iron: surface soil ingestion HQ = 2 (child)
  surface soil dermal contact HQ = 0.1 (child)
  subsurface soil ingestion HQ = 2 (child)
  subsurface soil and dermal contact HQ = 0.2 (child)
- manganese: subsurface soil ingestion HQ = 0.4 (child)
  subsurface soil inhalation HQ = 1 (child)

6.4.4.24 Transformer Storage Building and Utility Poles

The pathways evaluated at the Transformer Storage Building and Utility Poles are soil ingestion, dermal contact, and inhalation of suspended soil particulates for all receptors. The RME risk characterization summary for this CERFA site is presented in **Table 6-72**, and COCs for each pathway and receptor are listed in **Tables 6-73** through **6-76**.

Industrial Scenario

For industrial workers exposed to surface soil, the combined cancer risk under RME assumptions is 2×10^{-4}, which exceeds the target cancer risk of 1×10^{-4}. The combined RME HI of 1 equals but does not exceed the target HI of 1. The following COCs were identified for the industrial worker based on cancer effects:

- Aroclor-1248: surface soil ingestion cancer risk = 2×10^{-5}
  surface soil dermal contact cancer risk = 3×10^{-5}

Table 6-72. RME Risk Characterization Summary for Study Area PO (Current/Future and Future Land Uses)
Downed Utility Poles with Transformers, Alabama Army Ammunition Plant, Childersburg, Alabama

Medium	Exposure Route	Cancer Risk: Industrial Worker	Cancer Risk: Construction Worker	Cancer Risk: Recreational Child	Cancer Risk: Recreational Adult	Cancer Risk: Residential Child	Cancer Risk: Residential Adult	Noncancer HI: Industrial Worker	Noncancer HI: Construction Worker	Noncancer HI: Recreational Child	Noncancer HI: Recreational Adult	Noncancer HI: Residential Child	Noncancer HI: Residential Adult
Surface Soil (0 to <1 ft BLS)	Ingestion	7E-05 B	5E-05 B	4E-05 B	4E-05 B	6E-04 E	6E-04 E	6E-01 B	2E+00 E	4E-01 B	2E-01 B	2E+01 E	2E+00 E
	Dermal Contact	9E-05 B	7E-06 B	2E-05 B	2E-05 B	2E-04 E	2E-04 E	7E-01 B	3E-01 B	2E-01 B	1E-01 B	2E+00 E	1E+00 B
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**2E-04 E**	**6E-05 B**	**7E-05 B**	**7E-05 B**	**8E-04 E**	**8E-04 E**	**1E+00 B**	**3E+00 E**	**5E-01 B**	**4E-01 B**	**2E+01 E**	**3E+00 E**
Subsurface Soil (1 to 10 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	NA	1E-01 B	NA	NA	4E-01 B	5E-02 B
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	2E-02 B	NA	NA	8E-02 B	5E-02 B
	Inhalation	NA	1E-07 B	NA	NA	4E-06 B	4E-06 B	NA	4E-03	NA	NA	2E-02 B	5E-03 B
	Subtotal	**NA**	**1E-07 B**	**NA**	**NA**	**4E-06 B**	**4E-06 B**	**NA**	**2E-01 B**	**NA**	**NA**	**5E-01 B**	**1E-01 B**
Sediment	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Surface Water	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Groundwater	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Rabbit	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Fish	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Surface Soil (0 to <1 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								1E+00 B	3E+00 E	5E-01 B	4E-01 B	2E+01 E	3E+00 E
Combined Cancer Risk:		2E-04 E	6E-05 B	7E-05 B	7E-05 B	8E-04 E	8E-04 E						
Subsurface Soil (1 to 10 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	2E-01 B	NA	NA	5E-01 B	1E-01 B
Combined Cancer Risk:		NA	1E-07 B	NA	NA	4E-06 B	4E-06 B						

NA - pathway not evaluated or all detected chemicals eliminated as COPCs
0E+00 - pathway evaluated but no risks could be calculated due to lack of EPA-approved toxicity values
B - HI < 1 or ELCR < 10^{-4}
E - HI > 1 or ELCR > 10^{-4}

Table 6-73. Summary of Receptor Risks and Hazards for COCs at Study Area PO
Reasonable Maximum Exposure
Downed Utility Poles with Transformers, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Current/Future
Receptor Population: Industrial Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Soil	Downed Utility Poles with Transformers	Aroclor 1248	2.422E-05	--	3.121E-05	5.543E-05	Aroclor 1248	--	--	--	--	--
			Aroclor 1254	8.212E-06	--	1.058E-05	1.880E-05	Aroclor 1254	--	--	--	--	--
			Aroclor 1260	3.564E-05	--	4.594E-05	8.159E-05	Aroclor 1260	--	--	--	--	--
			(Total)	6.807E-05	--	8.774E-05	0.000156	(Total)	--	--	--	--	--
	Air	Downed Utility Poles with Transformers	Aroclor 1248	--	--	--	--	Aroclor 1248	--	--	--	--	--
			Aroclor 1254	--	--	--	--	Aroclor 1254	--	--	--	--	--
			Aroclor 1260	--	--	--	--	Aroclor 1260	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--

Table 6-74. Summary of Receptor Risks and Hazards for COCs at Study Area PO
Reasonable Maximum Exposure
Downed Utillty Poles with Transformers, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Soil	Downed Utility Poles with Transformers	Aroclor 1248	--	--	--	--	Aroclor 1248	--	--	--	--	--
			Aroclor 1254	--	--	--	--	Aroclor 1254	eyes	2.21	--	0.296	2.50
			Aroclor 1260	--	--	--	--	Aroclor 1260	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	2.21	--	0.296	2.50
	Air	Downed Utility Poles with Transformers	Aroclor 1248	--	--	--	--	Aroclor 1248	--	--	--	--	--
			Aroclor 1254	--	--	--	--	Aroclor 1254	--	--	--	--	--
			Aroclor 1260	--	--	--	--	Aroclor 1260	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
Subsurface Soil	Soil	Downed Utility Poles with Transformers	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
	Air	Downed Utility Poles with Transformers	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--

Table 6-75. Summary of Receptor Risks and Hazards for COCs at Study Area PO
Reasonable Maximum Exposure
Downed Utility Poles with Transformers, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Soil	Downed Utility Poles with Transformers	Aroclor 1248	0.000217	--	5.891E-05	0.000276	Aroclor 1248	--	--	--	--	--
			Aroclor 1254	7.358E-05	--	1.998E-05	9.356E-05	Aroclor 1254	eyes	15	--	1.68	17
			Aroclor 1260	0.000319	--	8.671E-05	0.000406	Aroclor 1260	--	--	--	--	--
			(Total)	0.000610	--	0.000166	0.000776	(Total)	--	15	--	1.68	17
	Air	Downed Utility Poles with Transformers	Aroclor 1248	--	--	--	--	Aroclor 1248	--	--	--	--	--
			Aroclor 1254	--	--	--	--	Aroclor 1254	--	--	--	--	--
			Aroclor 1260	--	--	--	--	Aroclor 1260	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
Subsurface Soil	Soil	Downed Utility Poles with Transformers	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
	Air	Downed Utility Poles with Transformers	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--

Table 6-76. Summary of Receptor Risks and Hazards for COCs at Study Area PO
Reasonable Maximum Exposure
Downed Utility Poles with Transformers, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Soil	Downed Utility Poles with Transformers	Aroclor 1248	0.000217	--	5.891E-05	0.000276	Aroclor 1248	--	--	--	--	--
			Aroclor 1254	7.358E-05	--	1.998E-05	9.356E-05	Aroclor 1254	eyes	1.61	--	1.04	2.65
			Aroclor 1260	0.000319	--	8.671E-05	0.000406	Aroclor 1260	--	--	--	--	--
			(Total)	0.000610	--	0.000166	0.000776	(Total)	--	1.61	--	1.04	2.65
	Air	Downed Utility Poles with Transformers	Aroclor 1248	--	--	--	--	Aroclor 1248	--	--	--	--	--
			Aroclor 1254	--	--	--	--	Aroclor 1254	--	--	--	--	--
			Aroclor 1260	--	--	--	--	Aroclor 1260	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
Subsurface Soil	Soil	Downed Utility Poles with Transformers	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
	Air	Downed Utility Poles with Transformers	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--

- Aroclor-1254: surface soil ingestion cancer risk = 8×10^{-6}
  surface soil dermal contact cancer risk = 1×10^{-5}

- Aroclor-1260: surface soil ingestion cancer risk = 4×10^{-5}
  surface soil dermal contact cancer risk = 5×10^{-5}

Construction Scenario

For construction workers exposed to soil, the combined cancer risks under RME assumptions are 6×10^{-5} for surface soil exposure and 1×10^{-7} for subsurface soil exposure which are below the target cancer risk of 1×10^{-4}. The combined RME HIs are 3 for surface soil exposure and 0.2 for subsurface soil exposure. The combined surface soil hazard index exceeds the target HI of 1. Noncancer effects were segregated according to target organ. The surface soil TOHI for the eyes exceeds the target HI of 1. Therefore, the following COC was identified for the construction worker based on noncancer effects:

- Aroclor-1254: surface soil ingestion HQ = 2
  surface soil dermal contact HQ = 0.3

Recreational Scenario

For recreational receptors exposed to surface soil, the combined RME cancer risk for the integrated child or adult receptor is 7×10^{-5}, which is below the target cancer risk of 1×10^{-4}. The combined RME HIs of 0.5 for the child and 0.4 for the adult fall below the target HI of 1. Therefore, no COCs were identified for recreational receptors.

Residential Scenario

The combined RME cancer risks for the integrated child or adult resident are 8×10^{-4} for exposure to surface soil and 4×10^{-6} for exposure to subsurface soil. For noncancer effects, the combined RME HIs are 20 and 0.5 (surface and subsurface soil exposures, respectively for the child), and 3 and 0.1 (surface and subsurface soil exposures, respectively for the adult). The combined surface soil cancer risk and hazard indices exceed regulatory criteria. Noncancer effects were segregated according to target organ. In surface soils, the medium TOHI for the eyes exceeds the target HI for the child and the adult. The following COCs were identified for residents based on cancer and noncancer effects:

- Aroclor-1248: surface soil ingestion cancer risk = 2×10^{-4}
  surface soil dermal contact cancer risk = 6×10^{-5}

- Aroclor-1254: surface soil ingestion cancer risk = 7×10^{-5}
  surface soil dermal contact cancer risk = 2×10^{-5}

surface soil ingestion HQ = 15 (child), 2 (adult)
surface soil dermal contact HQ = 2 (child), 1 (adult)

- Aroclor-1260: surface soil ingestion cancer risk = 3×10^{-4}
  surface soil dermal contact cancer risk = 9×10^{-5}

6.4.4.25 Underground Storage Tanks

The pathways evaluated at the Underground Storage Tanks are soil ingestion, dermal contact, and inhalation of suspended soil particulates for the construction worker and resident receptors. The RME risk characterization summary for this CERFA site is presented in **Table 6-77** and COCs are listed in **Table 6-78**.

Industrial Scenario

Industrial workers were assumed to be exposed only to surface soils. Risks were not calculated for industrial workers because surface soil samples were not collected at this site.

Construction Scenario

For construction workers exposed to subsurface soil, the combined cancer risk under RME assumptions is 3×10^{-7}, which falls below the target cancer risk of 1×10^{-4}. The combined RME HI is 3, which exceeds the target HI of 1. Noncancer effects were segregated according to target organ. The medium TOHIs for subsurface soil do not exceed the target HI. Therefore, no COCs were identified for the construction worker.

Recreational Scenario

Recreational receptors were assumed to be exposed only to surface soils. Risks were not calculated for recreational receptors because surface soil samples were not collected at this site.

Residential Scenario

The combined RME cancer risk for the integrated child or adult resident is 5×10^{-6} for exposure to subsurface soil, which is below the target cancer risk of 1×10^{-4}. For noncancer effects, the combined RME HIs are 8 for the child and 2 for the adult. Noncancer effects were segregated according to target organ. For the resident child, the medium TOHI for the central nervous system exceeds the target HI in subsurface soils. The following COCs were identified for residents based on noncancer effects:

- iron: subsurface soil ingestion HQ = 2 (child)
  subsurface soil dermal contact HQ = 0.1 (child)

Table 6-77. RME Risk Characterization Summary for Study Area US (Current/Future and Future Land Uses) Underground Storage Tanks, Alabama Army Ammunition Plant, Childersburg, Alabama

Medium	Exposure Route	Cancer Risk: Industrial Worker	Cancer Risk: Construction Worker	Cancer Risk: Recreational Child	Cancer Risk: Recreational Adult	Cancer Risk: Residential Child	Cancer Risk: Residential Adult	Noncancer HI: Industrial Worker	Noncancer HI: Construction Worker	Noncancer HI: Recreational Child	Noncancer HI: Recreational Adult	Noncancer HI: Residential Child	Noncancer HI: Residential Adult
Surface Soil (0 to <1 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Subsurface Soil (1 to 10 ft BLS)	Ingestion	NA	2E-07 B	NA	NA	3E-06 B	3E-06 B	NA	1E+00 B	NA	NA	4E+00 E	4E-01 B
	Dermal Contact	NA	9E-08 B	NA	NA	2E-06 B	2E-06 B	NA	3E-01 B	NA	NA	6E-01 B	4E-01 B
	Inhalation	NA	3E-08 B	NA	NA	7E-07 B	7E-07 B	NA	9E-01	NA	NA	4E+00 E	1E+00 B
	Subtotal	NA	3E-07 B	NA	NA	5E-06 B	5E-06 B	NA	3E+00 E	NA	NA	8E+00 E	2E+00 E
Sediment	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface Water	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Groundwater	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Rabbit	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fish	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface Soil (0 to <1 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	NA	NA	NA	NA	NA
Combined Cancer Risk:		NA	NA	NA	NA	NA	NA						
Subsurface Soil (1 to 10 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	3E+00 E	NA	NA	8E+00 E	2E+00 E
Combined Cancer Risk:		NA	3E-07 B	NA	NA	5E-06 B	5E-06 B						

NA - pathway not evaluated or all detected chemicals eliminated as COPCs
0E+00 - pathway evaluated but no risks could be calculated due to lack of EPA-approved toxicity values
B - HI ≤ 1 or ELCR ≤ 10^{-4}
E - HI > 1 or ELCR > 10^{-4}

Table 6-78. Summary of Receptor Risks and Hazards for COCs at Study Area US
Reasonable Maximum Exposure
Underground Storage Tanks, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Subsurface Soil	Soil	Underground Storage Tanks	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	1.99	--	0.133	2.13
			Manganese	--	--	--	--	Manganese	CNS	1.12	--	0.281	1.40
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			Benzo(a)pyrene	--	--	--	--	Benzo(a)pyrene	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	3.11	--	0.415	3.53
	Air	Underground Storage Tanks	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	--	3.81	--	3.81
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			Benzo(a)pyrene	--	--	--	--	Benzo(a)pyrene	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	3.81	--	3.81

- manganese: subsurface soil ingestion HQ = 1 (child)
  subsurface soil dermal contact HQ = 0.3 (child)
  subsurface soil inhalation HQ = 4 (child)

6.4.4.26 Gas Station

At the Gas Station, all detected chemicals in subsurface soils were eliminated as COPCs in the comparison to background or RBCs. Surface soil samples were not collected at this site. Therefore, no risk exceeding regulatory targets is posed by subsurface soil exposure at the Gas Station.

6.4.4.27 Fertilizer and Pesticide Storage Building

The pathways evaluated at the Fertilizer and Pesticide Storage Building are soil ingestion, dermal contact, and inhalation of suspended soil particulates for all receptors. The RME risk characterization summary for this CERFA site is presented in **Table 6-79**, and COCs for each pathway and receptor are listed in **Tables 6-80** and **6-81**.

Industrial Scenario

For industrial workers exposed to surface soil, the combined cancer risk under RME assumptions is 7×10^{-6}, which falls below the target cancer risk of 1×10^{-4}. The combined RME HI of 0.2 falls below the target HI of 1. Therefore, no COCs were identified for the industrial worker at the Fertilizer and Pesticide Storage Building.

Construction Scenario

For construction workers exposed to soil, the combined cancer risks under RME assumptions are 4×10^{-6} for surface soil exposure and 9×10^{-8} for subsurface soil exposure. The combined RME HIs are 1 for surface soil exposure and 3 for subsurface soil exposure. The latter exceeds the target HI of 1. Noncancer effects were segregated according to target organ. The following COC was identified for the construction worker at the Fertilizer and Pesticide Storage Building based on noncancer effects:

- iron: subsurface soil ingestion HQ = 1
  subsurface soil dermal contact HQ = 0.1

Recreational Scenario

For recreational receptors exposed to surface soil, the combined RME cancer risk for the integrated child or adult receptor is 4×10^{-6}, which is below the target cancer risk of 1×10^{-4}. The

Table 6-79. RME Risk Characterization Summary for Study Area PS (Current/Future and Future Land Uses) Fertilizer and Pesticide Storage Building, Alabama Army Ammunition Plant, Childersburg, Alabama

Medium	Exposure Route	Cancer Risk: Industrial Worker	Cancer Risk: Construction Worker	Cancer Risk: Recreational Child	Cancer Risk: Recreational Adult	Cancer Risk: Residential Child	Cancer Risk: Residential Adult	Noncancer HI: Industrial Worker	Noncancer HI: Construction Worker	Noncancer HI: Recreational Child	Noncancer HI: Recreational Adult	Noncancer HI: Residential Child	Noncancer HI: Residential Adult
Surface Soil (0 to <1 ft BLS)	Ingestion	5E-06 B	4E-06 B	3E-06 B	3E-06 B	5E-05 B	5E-05 B	1E-01 B	1E+00 B	7E-02 B	5E-02 B	3E+00 E	3E-01 B
	Dermal Contact	1E-06 B	1E-07 B	4E-07 B	4E-07 B	3E-06 B	3E-06 B	9E-02 B	8E-02 B	2E-02 B	2E-02 B	2E-01 B	1E-01 B
	Inhalation	9E-07 B	9E-08 B	2E-07 B	2E-07 B	2E-06 B	2E-06 B	8E-04 B	1E-03 B	2E-04 B	7E-05 B	4E-03 B	1E-03 B
	Subtotal	**7E-06 B**	**4E-06 B**	**4E-06 B**	**4E-06 B**	**5E-05 B**	**5E-05 B**	**2E-01 B**	**1E+00 B**	**9E-02 B**	**6E-02 B**	**3E+00 E**	**4E-01 B**
Subsurface Soil (1 to 10 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	NA	2E+00 E	NA	NA	5E+00 E	6E-01 B
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	3E-01 B	NA	NA	7E-01 B	5E-01 B
	Inhalation	NA	9E-08 B	NA	NA	2E-06 B	2E-06 B	NA	5E-01	NA	NA	2E+00 E	6E-01 B
	Subtotal	**NA**	**9E-08 B**	**NA**	**NA**	**2E-06 B**	**2E-06 B**	**NA**	**3E+00 E**	**NA**	**NA**	**8E+00 E**	**2E+00 E**
Sediment	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Surface Water	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Groundwater	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Rabbit	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Fish	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Surface Soil (0 to <1 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								2E-01 B	1E+00 B	9E-02 B	6E-02 B	3E+00 E	4E-01 B
Combined Cancer Risk:		7E-06 B	4E-06 B	4E-06 B	4E-06 B	5E-05 B	5E-05 B						
Subsurface Soil (1 to 10 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	3E+00 E	NA	NA	8E+00 E	2E+00 E
Combined Cancer Risk:		NA	9E-08 B	NA	NA	2E-06 B	2E-06 B						

NA - pathway not evaluated or all detected chemicals eliminated as COPCs
0E+00 - pathway evaluated but no risks could be calculated due to lack of EPA-approved toxicity values
B - HI ≤ 1 or ELCR ≤ 10^{-4}
E - HI > 1 or ELCR > 10^{-4}

Table 6-80. Summary of Receptor Risks and Hazards for COCs at Study Area PS
Reasonable Maximum Exposure
Fertilizer and Pesticide Storage Building, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Soil	Fertilizer and Pesticide Storage Building	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
	Air	Fertilizer and Pesticide Storage Building	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
Subsurface Soil	Soil	Fertilizer and Pesticide Storage Building	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	1.47	--	0.119	1.59
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	1.47	--	0.119	1.59
	Air	Fertilizer and Pesticide Storage Building	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	--	--	--	--	--
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--

Table 6-81. Summary of Receptor Risks and Hazards for COCs at Study Area PS
Reasonable Maximum Exposure
Fertilizer and Pesticide Storage Building, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Soil	Fertilizer and Pesticide Storage Building	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	1.83	--	0.123	1.95
			(Total)	--	--	--	--	(Total)	--	1.83	--	0.123	1.95
	Air	Fertilizer and Pesticide Storage Building	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	--	--	--	--	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--
Subsurface Soil	Soil	Fertilizer and Pesticide Storage Building	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	4.01	--	0.268	4.27
			Manganese	--	--	--	--	Manganese	CNS	0.586	--	0.147	0.733
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	4.59	--	0.416	5.01
	Air	Fertilizer and Pesticide Storage Building	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	--	1.99	--	1.99
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	1.99	--	1.99

combined RME HIs of 0.09 for the child and 0.06 for the adult fall below the target HI of 1. Therefore, no COCs were identified for recreational receptors at the Fertilizer and Pesticide Storage Building.

Residential Scenario

The combined RME cancer risks for the integrated child or adult resident are 5×10^{-5} for exposure to surface soil and 2×10^{-6} for exposure to subsurface soil. Both are below the target cancer risk of 1×10^{-4}. For noncancer effects, the combined RME HIs are 3 and 8 (surface and subsurface soil exposures, respectively for the child) and 0.4 and 2 (surface and subsurface soil exposures, respectively for the adult). Noncancer effects were segregated according to target organ. For the resident child, the medium TOHI for the central nervous system exceeds the target HI in subsurface soils. The following COCs were identified for residents at the Fertilizer and Pesticide Storage Building based on noncancer effects:

- iron: surface soil ingestion HQ = 2 (child)
  surface soil dermal contact HQ = 0.1 (child)
  subsurface soil ingestion HQ = 4 (child)
  subsurface soil dermal contact HQ = 0.3 (child)
- manganese: subsurface soil ingestion HQ = 0.6 (child)
  subsurface soil dermal contact HQ = 0.1 (child)
  subsurface soil inhalation HQ = 2 (child)

6.4.4.28 Talladega Creek

The pathways evaluated for Talladega Creek are ingestion of and dermal contact with sediment and surface water, and ingestion of fish for recreational and residential receptors. The RME risk characterization summary for Talladega Creek is presented in **Table 6-82**.

Recreational Scenario

The combined RME cancer risk for the integrated child or adult receptor is 1×10^{-6}, which falls below the target cancer risk of 1×10^{-4}. The combined RME HIs of 0.1 for the child and 0.08 for the adult fall below the target HI of 1. Therefore, no COCs were identified for recreational receptors at Talladega Creek.

Residential Scenario

The combined RME cancer risk for the integrated child or adult resident is 5×10^{-6}, which falls below the target cancer risk of 1×10^{-4}. The combined RME HIs of 0.5 for the resident child and 0.1 for the adult fall below the target HI of 1. No COCs were identified for residents at Talladega Creek.

Table 6-82. RME Risk Characterization Summary for Study Area TA (Current/Future and Future Land Uses)
Talladega Creek, Alabama Army Ammunition Plant, Childersburg, Alabama

Medium	Exposure Route	Cancer Risk: Industrial Worker	Cancer Risk: Construction Worker	Cancer Risk: Recreational Child	Cancer Risk: Recreational Adult	Cancer Risk: Residential Child	Cancer Risk: Residential Adult	Noncancer HI: Industrial Worker	Noncancer HI: Construction Worker	Noncancer HI: Recreational Child	Noncancer HI: Recreational Adult	Noncancer HI: Residential Child	Noncancer HI: Residential Adult
Surface Soil (0 to <1 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Subsurface Soil (1 to 10 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sediment	Ingestion	NA	NA	1E-06 B	1E-06 B	4E-06 B	4E-06 B	NA	NA	2E-02 B	1E-02 B	2E-01 B	2E-02 B
	Dermal Contact	NA	NA	1E-07 B	1E-07 B	3E-07 B	3E-07 B	NA	NA	1E-02 B	1E-02 B	4E-02 B	2E-02 B
	Subtotal	NA	NA	1E-06 B	1E-06 B	5E-06 B	5E-06 B	NA	NA	3E-02 B	3E-02 B	3E-01 B	5E-02 B
Surface Water	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Groundwater	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Rabbit	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fish	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	8E-02 B	5E-02 B	2E-01 B	5E-02 B
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	8E-02 B	5E-02 B	2E-01 B	5E-02 B
Surface Soil (0 to <1 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	NA	1E-01 B	8E-02 B	5E-01 B	1E-01 B
Combined Cancer Risk:		NA	NA	1E-06 B	1E-06 B	5E-06 B	5E-06 B						
Subsurface Soil (1 to 10 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	NA	1E-01 B	8E-02 B	5E-01 B	1E-01 B
Combined Cancer Risk:		NA	NA	1E-06 B	1E-06 B	5E-06 B	5E-06 B						

NA - pathway not evaluated or all detected chemicals eliminated as COPCs
0E+00 - pathway evaluated but no risks could be calculated due to lack of EPA-approved toxicity values
B - HI $\leq$ 1 or ELCR $\leq 10^{-4}$
E - HI > 1 or ELCR > 10^{-4}

6.4.4.29 Coosa River

The pathways evaluated for the Coosa River are ingestion of and dermal contact with sediment and surface water for recreational and residential receptors. The RME risk characterization summary for the Coosa River is presented in **Table 6-83**.

Recreational Scenario

The combined RME cancer risk for the integrated child or adult receptor is 2×10^{-7}, which falls below the target cancer risk of 1×10^{-4}. The combined RME HIs of 0.008 for the child and 0.006 for the adult fall below the target HI of 1. Therefore, no COCs were identified for recreational receptors at the Coosa River.

Residential Scenario

The combined RME cancer risk for the integrated child or adult resident is 6×10^{-7}, which falls below the target cancer risk of 1×10^{-4}. The combined RME HIs of 0.05 for the resident child and 0.01 for the adult fall below the target HI of 1. Therefore, no COCs were identified for residents at the Coosa River.

6.4.4.30 Groundwater -- Study Areas 16 and 19

Exposure to groundwater was evaluated only under the residential land use scenario. Residents were assumed to be exposed to groundwater through ingestion, dermal contact, and inhalation of volatile compounds. The RME risk characterization summary for groundwater at Study Areas 16 and 19 is presented in **Table 6-84**, and COCs for each pathway and receptor are listed in **Tables 6-85** and **6-86**.

The maximum detected concentration of lead in groundwater at Study Areas 16 and 19 exceeds the 15 µg/L screening level (EPA 1995c). Therefore, models were used to estimate blood lead levels in resident children.

Residential Scenario

The combined RME cancer risk for the integrated child or adult receptor is 5×10^{-3}, which exceeds the target cancer risk of 1×10^{-4}. The combined RME HIs of 20 for the child and 10 for the adult exceed the target HI of 1. The 95th percentile mean blood lead concentration in the resident child exposed to groundwater is 6 µg/dL, which is below the CDC target of 10 µg/dL. The following COCs were identified in groundwater for residents at Study Areas 16 and 19 based on cancer and noncancer effects:

- iron: groundwater ingestion HQ = 2 (child)

Table 6-83. RME Risk Characterization Summary for Study Area CO (Current/Future and Future Land Uses)
Coosa River, Alabama Army Ammunition Plant, Childersburg, Alabama

Medium	Exposure Route	Cancer Risk: Industrial Worker	Cancer Risk: Construction Worker	Cancer Risk: Recreational Child	Cancer Risk: Recreational Adult	Cancer Risk: Residential Child	Cancer Risk: Residential Adult	Noncancer HI: Industrial Worker	Noncancer HI: Construction Worker	Noncancer HI: Recreational Child	Noncancer HI: Recreational Adult	Noncancer HI: Residential Child	Noncancer HI: Residential Adult
Surface Soil (0 to < 1 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Subsurface Soil (1 to 10 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sediment	Ingestion	NA	NA	7E-08 B	7E-08 B	3E-07 B	3E-07 B	NA	NA	4E-03 B	2E-03 B	4E-02 B	4E-03 B
	Dermal Contact	NA	NA	1E-07 B	1E-07 B	2E-07 B	2E-07 B	NA	NA	4E-03 B	3E-03 B	1E-02 B	6E-03 B
	Subtotal	NA	NA	2E-07 B	2E-07 B	5E-07 B	5E-07 B	NA	NA	8E-03 B	6E-03 B	5E-02 B	1E-02 B
Surface Water	Ingestion	NA	NA	3E-08 B	3E-08 B	9E-08 B	9E-08 B	NA	NA	5E-04 B	7E-05 B	3E-03 B	1E-04 B
	Dermal Contact	NA	NA	1E-08 B	1E-08 B	2E-08 B	2E-08 B	NA	NA	2E-04 B	2E-04 B	5E-04 B	3E-04 B
	Subtotal	NA	NA	4E-08 B	4E-08 B	1E-07 B	1E-07 B	NA	NA	7E-04 B	2E-04 B	3E-03 B	4E-04 B
Groundwater	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Rabbit	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fish	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface Soil (0 to < 1 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	NA	8E-03 B	6E-03 B	5E-02 B	1E-02 B
Combined Cancer Risk:		NA	NA	2E-07 B	2E-07 B	6E-07 B	6E-07 B						
Subsurface Soil (1 to 10 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	NA	8E-03 B	6E-03 B	5E-02 B	1E-02 B
Combined Cancer Risk:		NA	NA	2E-07 B	2E-07 B	6E-07 B	6E-07 B						

NA - pathway not evaluated or all detected chemicals eliminated as COPCs
0E+00 - pathway evaluated but no risks could be calculated due to lack of EPA-approved toxicity values
B - HI $\leq$ 1 or ELCR $\leq 10^{-4}$
E - HI > 1 or ELCR > 10^{-4}

Table 6-84. RME Risk Characterization Summary for Study Area GWA (Current/Future and Future Land Uses) Study Areas 16/19, Alabama Army Ammunition Plant, Childersburg, Alabama

Medium	Exposure Route	Cancer Risk: Industrial Worker	Cancer Risk: Construction Worker	Cancer Risk: Recreational Child	Cancer Risk: Recreational Adult	Cancer Risk: Residential Child	Cancer Risk: Residential Adult	Noncancer HI: Industrial Worker	Noncancer HI: Construction Worker	Noncancer HI: Recreational Child	Noncancer HI: Recreational Adult	Noncancer HI: Residential Child	Noncancer HI: Residential Adult
Surface Soil (0 to <1 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Subsurface Soil (1 to 10 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sediment	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface Water	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Groundwater	Ingestion	NA	NA	NA	NA	5E-03 E	5E-03 E	NA	NA	NA	NA	2E+01 E	1E+01 E
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	5E-03 E	5E-03 E	NA	NA	NA	NA	2E+01 E	1E+01 E
Rabbit	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fish	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface Soil (0 to <1 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	NA	NA	NA	2E+01 E	1E+01 E
Combined Cancer Risk:		NA	NA	NA	NA	5E-03 E	5E-03 E						
Subsurface Soil (1 to 10 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	NA	NA	NA	2E+01 E	1E+01 E
Combined Cancer Risk:		NA	NA	NA	NA	5E-03 E	5E-03 E						

NA - pathway not evaluated or all detected chemicals eliminated as COPCs
0E+00 - pathway evaluated but no risks could be calculated due to lack of EPA-approved toxicity values
B - HI $\leq$ 1 or ELCR $< 10^{-4}$
E - HI > 1 or ELCR $> 10^{-4}$

Table 6-85. Summary of Receptor Risks and Hazards for COCs at Study Area GWA
Reasonable Maximum Exposure
Study Areas 16/19, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Study Areas 16/19	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	2.19	--	--	2.19
			Manganese	--	--	--	--	Manganese	CNS	2.74	--	--	2.74
			2,4,6-Trinitrotoluene	1.626E-05	--	--	1.626E-05	2,4,6-Trinitrotoluene	liver	4.66	--	--	4.66
			2,4-Dinitrotoluene	0.00475	--	--	0.00475	2,4-Dinitrotoluene	CNS	15	--	--	15
			2,6-Dinitrotoluene	5.120E-06	--	--	5.120E-06	2,6-Dinitrotoluene	--	--	--	--	--
			2-Amino-4,6-Dinitrotoluene	2.283E-06	--	--	2.283E-06	2-Amino-4,6-Dinitrotoluene	--	--	--	--	--
			4-Amino-2,6-Dinitrotoluene	1.041E-05	--	--	1.041E-05	4-Amino-2,6-Dinitrotoluene	--	--	--	--	--
			Pentachlorophenol	4.212E-06	--	--	4.212E-06	Pentachlorophenol	--	--	--	--	--
			RDX	1.038E-06	--	--	1.038E-06	RDX	--	--	--	--	--
			bis(2-Ethylhexyl)phthalate	5.681E-06	--	--	5.681E-06	bis(2-Ethylhexyl)phthalate	--	--	--	--	--
			(Total)	0.00480	--	--	0.00480	(Total)	--	25	--	--	25

Table 6-86. Summary of Receptor Risks and Hazards for COCs at Study Area GWA
Reasonable Maximum Exposure
Study Areas 16/19, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Study Areas 16/19	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	1.18	--	--	1.18
			2,4,6-Trinitrotoluene	1.626E-05	--	--	1.626E-05	2,4,6-Trinitrotoluene	liver	2.00	--	--	2.00
			2,4-Dinitrotoluene	0.00475	--	--	0.00475	2,4-Dinitrotoluene	CNS	6.44	--	--	6.44
			2,6-Dinitrotoluene	5.120E-06	--	--	5.120E-06	2,6-Dinitrotoluene	--	--	--	--	--
			2-Amino-4,6-Dinitrotoluene	2.283E-06	--	--	2.283E-06	2-Amino-4,6-Dinitrotoluene	--	--	--	--	--
			4-Amino-2,6-Dinitrotoluene	1.041E-05	--	--	1.041E-05	4-Amino-2,6-Dinitrotoluene	--	--	--	--	--
			Pentachlorophenol	4.212E-06	--	--	4.212E-06	Pentachlorophenol	--	--	--	--	--
			RDX	1.038E-06	--	--	1.038E-06	RDX	--	--	--	--	--
			bis(2-Ethylhexyl)phthalate	5.681E-06	--	--	5.681E-06	bis(2-Ethylhexyl)phthalate	--	--	--	--	--
			(Total)	0.00480	--	--	0.00480	(Total)	--	10	--	--	10

- manganese: groundwater ingestion HQ = 3 (child), 1 (adult)
- 2,4,6-trinitrotoluene: groundwater ingestion cancer risk = 2×10^{-5}
  groundwater ingestion HQ = 5 (child), 2 (adult)
- 2,4-dinitrotoluene: groundwater ingestion cancer risk = 5×10^{-3}
  groundwater ingestion HQ = 15 (child), 6 (adult)
- 2-amino-4,6-dinitrotoluene: groundwater ingestion cancer risk = 2×10^{-6}
- 4-amino-2,6-dinitrotoluene: groundwater ingestion cancer risk = 1×10^{-5}
- pentachlorophenol: groundwater ingestion cancer risk = 4×10^{-6}
- cyclotrimethylenetrinitramine: groundwater ingestion cancer risk = 1×10^{-6}
  (RDX)
- bis(2-ethylhexyl)phthalate: groundwater ingestion cancer risk = 6×10^{-6}
- 2,6-dinitrotoluene: groundwater ingestion cancer risk = 5×10^{-6}

6.4.4.31 Groundwater – Main Industrial Area

Exposure to groundwater was evaluated only under the residential land use scenario. Residents were assumed to be exposed to groundwater through ingestion, dermal contact, and inhalation of volatile compounds. The RME risk characterization summary for groundwater at the Main Industrial Area is presented in **Table 6-87**, and COCs for each pathway and receptor are listed in **Tables 6-88** and **6-89**.

The maximum detected concentration of lead in groundwater at the Main Industrial Area exceeds the 15 µg/L screening level (EPA 1995c). Therefore, models were used to estimate blood lead levels in resident children.

Residential Scenario

The combined RME cancer risk for the integrated child or adult receptor is 2×10^{-1}, which exceeds the target cancer risk of 1×10^{-4}. The combined RME HIs of 800 for the child and 300 for the adult exceed the target HI of 1. The 95th percentile mean blood lead concentration in the resident child exposed to groundwater is 39 µg/dL, which is above the CDC target of 10 µg/dL. The following COCs were identified in groundwater for residents at the Main Industrial Area based on cancer and noncancer effects:

- arsenic: groundwater ingestion cancer risk = 8×10^{-5}

Table 6-87. RME Risk Characterization Summary for Study Area GWB (Current/Future and Future Land Uses) Main Industrial Area, Alabama Army Ammunition Plant, Childersburg, Alabama

Medium	Exposure Route	Cancer Risk						Noncancer HI					
		Industrial Worker	Construction Worker	Recreational Child	Recreational Adult	Residential Child	Residential Adult	Industrial Worker	Construction Worker	Recreational Child	Recreational Adult	Residential Child	Residential Adult
Surface Soil (0 to <1 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Subsurface Soil (1 to 10 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sediment	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface Water	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Groundwater	Ingestion	NA	NA	NA	NA	2E-01 E	2E-01 E	NA	NA	NA	NA	8E+02 E	3E+02 E
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	7E-06 B	7E-06 B	NA	NA	NA	NA	1E-01 B	6E-02 B
	Subtotal	NA	NA	NA	NA	2E-01 E	2E-01 E	NA	NA	NA	NA	8E+02 E	3E+02 E
Rabbit	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fish	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface Soil (0 to <1 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	NA	NA	NA	8E+02 E	3E+02 E
Combined Cancer Risk:		NA	NA	NA	NA	2E-01 E	2E-01 E						
Subsurface Soil (1 to 10 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	NA	NA	NA	8E+02 E	3E+02 E
Combined Cancer Risk:		NA	NA	NA	NA	2E-01 E	2E-01 E						

NA - pathway not evaluated or all detected chemicals eliminated as COPCs
0E+00 - pathway evaluated but no risks could be calculated due to lack of EPA-approved toxicity values
B - HI ≤ 1 or ELCR ≤ 10^{-4}
E - HI > 1 or ELCR > 10^{-4}

Table 6-88. Summary of Receptor Risks and Hazards for COCs at Study Area GWB
Reasonable Maximum Exposure
Main Industrial Area, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Main Industrial Area	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Antimony	--	--	--	--	Antimony	--	--	--	--	--
			Arsenic	8.185E-05	--	--	8.185E-05	Arsenic	--	--	--	--	--
			Barium	--	--	--	--	Barium	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Copper	--	--	--	--	Copper	--	--	--	--	--
			Hexavalent Chromium	--	--	--	--	Hexavalent Chromium	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	3.02	--	--	3.02
			Manganese	--	--	--	--	Manganese	CNS	2.53	--	--	2.53
			Mercury	--	--	--	--	Mercury	--	--	--	--	--
			Nickel	--	--	--	--	Nickel	--	--	--	--	--
			Thallium	--	--	--	--	Thallium	liver, blood	0.427	--	--	0.427
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			1,3-Dinitrobenzene	--	--	--	--	1,3-Dinitrobenzene	--	--	--	--	--
			2,4,6-Trinitrotoluene	2.856E-05	--	--	2.856E-05	2,4,6-Trinitrotoluene	liver	8.18	--	--	8.18
			2,4-Dinitrotoluene	0.210	--	--	0.210	2,4-Dinitrotoluene	CNS	743	--	--	743
			2,6-Dinitrotoluene	7.266E-05	--	--	7.266E-05	2,6-Dinitrotoluene	CNS, blood, kidney	0.459	--	--	0.459
			2-Amino-4,6-Dinitrotoluene	8.189E-06	--	--	8.189E-06	2-Amino-4,6-Dinitrotoluene	--	--	--	--	--
			2-Methylnaphthalene	--	--	--	--	2-Methylnaphthalene	--	--	--	--	--
			4-Amino-2,6-Dinitrotoluene	2.301E-05	--	--	2.301E-05	4-Amino-2,6-Dinitrotoluene	--	0.145	--	--	0.145
			Benzo(a)pyrene	4.343E-06	--	--	4.343E-06	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	1.629E-06	--	--	1.629E-06	Benzo(b)fluoranthene	--	--	--	--	--
			Carbon Tetrachloride	--	--	--	--	Carbon Tetrachloride	--	--	--	--	--
			Chloroform	--	--	--	--	Chloroform	--	--	--	--	--
			N-Nitrosodiphenylamine	--	--	--	--	N-Nitrosodiphenylamine	--	--	--	--	--
			Nitrobenzene	--	--	--	--	Nitrobenzene	blood, kidney, liver	0.102	--	--	0.102
			Pentachlorophenol	1.429E-05	--	--	1.429E-05	Pentachlorophenol	--	--	--	--	--
			RDX	1.530E-06	--	--	1.530E-06	RDX	--	--	--	--	--
			Vinyl Chloride	3.829E-05	--	--	3.829E-05	Vinyl Chloride	--	--	--	--	--
			bis(2-Ethylhexyl)phthalate	1.369E-06	--	--	1.369E-06	bis(2-Ethylhexyl)phthalate	--	--	--	--	--
			(Total)	0.210	--	--	0.210	(Total)	--	758	--	--	758
	Air	Main Industrial Area	2-Methylnaphthalene	--	--	--	--	2-Methylnaphthalene	--	--	--	--	--
			Carbon Tetrachloride	--	--	--	--	Carbon Tetrachloride	--	--	--	--	--
			Chloroform	--	--	--	--	Chloroform	--	--	--	--	--
			Nitrobenzene	--	--	--	--	Nitrobenzene	--	--	--	--	--
			Vinyl Chloride	--	5.925E-06	--	5.925E-06	Vinyl Chloride	--	--	--	--	--
			(Total)	--	5.925E-06	--	5.925E-06	(Total)	--	--	--	--	--

Table 6-89. Summary of Receptor Risks and Hazards for COCs at Study Area GWB
Reasonable Maximum Exposure
Main Industrial Area, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Main Industrial Area	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Antimony	--	--	--	--	Antimony	--	--	--	--	--
			Arsenic	8.185E-05	--	--	8.185E-05	Arsenic	--	--	--	--	--
			Barium	--	--	--	--	Barium	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Copper	--	--	--	--	Copper	--	--	--	--	--
			Hexavalent Chromium	--	--	--	--	Hexavalent Chromium	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	1.08	--	--	1.08
			Mercury	--	--	--	--	Mercury	--	--	--	--	--
			Nickel	--	--	--	--	Nickel	--	--	--	--	--
			Thallium	--	--	--	--	Thallium	liver, blood	0.183	--	--	0.183
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			1,3-Dinitrobenzene	--	--	--	--	1,3-Dinitrobenzene	--	--	--	--	--
			2,4,6-Trinitrotoluene	2.856E-05	--	--	2.856E-05	2,4,6-Trinitrotoluene	liver	3.51	--	--	3.51
			2,4-Dinitrotoluene	0.210	--	--	0.210	2,4-Dinitrotoluene	CNS	319	--	--	319
			2,6-Dinitrotoluene	7.266E-05	--	--	7.266E-05	2,6-Dinitrotoluene	CNS, blood, kidney	0.197	--	--	0.197
			2-Amino-4,6-Dinitrotoluene	8.189E-06	--	--	8.189E-06	2-Amino-4,6-Dinitrotoluene	--	--	--	--	--
			2-Methylnaphthalene	--	--	--	--	2-Methylnaphthalene	--	--	--	--	--
			4-Amino-2,6-Dinitrotoluene	2.301E-05	--	--	2.301E-05	4-Amino-2,6-Dinitrotoluene	--	--	--	--	--
			Benzo(a)pyrene	4.343E-06	--	--	4.343E-06	Benzo(a)pyrene	--	--	--	--	--
			Benzo(b)fluoranthene	1.629E-06	--	--	1.629E-06	Benzo(b)fluoranthene	--	--	--	--	--
			Carbon Tetrachloride	--	--	--	--	Carbon Tetrachloride	--	--	--	--	--
			Chloroform	--	--	--	--	Chloroform	--	--	--	--	--
			N-Nitrosodiphenylamine	--	--	--	--	N-Nitrosodiphenylamine	--	--	--	--	--
			Nitrobenzene	--	--	--	--	Nitrobenzene	--	--	--	--	--
			Pentachlorophenol	1.429E-05	--	--	1.429E-05	Pentachlorophenol	--	--	--	--	--
			RDX	1.530E-06	--	--	1.530E-06	RDX	--	--	--	--	--
			Vinyl Chloride	3.829E-05	--	--	3.829E-05	Vinyl Chloride	--	--	--	--	--
			bis(2-Ethylhexyl)phthalate	1.369E-06	--	--	1.369E-06	bis(2-Ethylhexyl)phthalate	--	--	--	--	--
			(Total)	0.210	--	--	0.210	(Total)	--	324	--	--	324
	Air	Main Industrial Area	2-Methylnaphthalene	--	--	--	--	2-Methylnaphthalene	--	--	--	--	--
			Carbon Tetrachloride	--	--	--	--	Carbon Tetrachloride	--	--	--	--	--
			Chloroform	--	--	--	--	Chloroform	--	--	--	--	--
			Nitrobenzene	--	--	--	--	Nitrobenzene	--	--	--	--	--
			Vinyl Chloride	--	5.925E-06	--	5.925E-06	Vinyl Chloride	--	--	--	--	--
			(Total)	--	5.925E-06	--	5.925E-06	(Total)	--	--	--	--	--

- iron: groundwater ingestion HQ = 3 (child)
- lead: groundwater, 95th percentile mean blood lead level = 39 μg/dL
- manganese: groundwater ingestion HQ = 3 (child), 1 (adult)
- thallium: groundwater ingestion HQ = 0.4 (child), 0.2 (adult)
- 2,4,6-trinitrotoluene: groundwater ingestion cancer risk = 3×10^{-5} groundwater ingestion HQ = 8 (child), 4 (adult)
- 2,4-dinitrotoluene: groundwater ingestion cancer risk = 2×10^{-1} groundwater ingestion HQ = 700 (child), 300 (adult)
- 2,6-dinitrotoluene: groundwater ingestion cancer risk = 7×10^{-5} groundwater ingestion HQ = 0.5 (child), 0.2 (adult)
- 2-amino-4,6-dinitrotoluene: groundwater ingestion cancer risk = 8×10^{-6}
- 4-amino-2,6-dinitrotoluene: groundwater ingestion cancer risk = 2×10^{-5} groundwater ingestion HQ = 0.1 (child)
- benzo(a)pyrene: groundwater ingestion cancer risk = 4×10^{-6}
- benzo(b)fluoranthene: groundwater ingestion cancer risk = 2×10^{-6}
- nitrobenzene: groundwater ingestion HQ = 0.1 (child)
- pentachlorophenol: groundwater ingestion cancer risk = 1×10^{-5}
- RDX: groundwater ingestion cancer risk = 2×10^{-6}
- vinyl chloride: groundwater ingestion cancer risk = 4×10^{-5} groundwater dermal contact/inhalation cancer risk = 6×10^{-6}
- bis(2-ethylhexyl)phthalate: groundwater ingestion cancer risk = 1×10^{-6}

6.4.4.32 Groundwater – Blending/Shipping Area

Exposure to groundwater was evaluated only under the residential land use scenario. Residents were assumed to be exposed to groundwater through ingestion, dermal contact, and inhalation of volatile compounds. The RME risk characterization summary for groundwater at the

Blending/Shipping Area is presented in **Table 6-90**, and COCs for each pathway and receptor are listed in **Tables 6-91** and **6-92**.

The maximum detected concentration of lead in groundwater at the Blending/Shipping Area exceeds the 15 µg/L screening level (EPA 1995c). Therefore, models were used to estimate blood lead levels in resident children.

Residential Scenario

The combined RME cancer risk for the integrated child or adult receptor is 5×10^{-2}, which exceeds the target cancer risk of 1×10^{-4}. The combined RME HIs of 400 for the child and 200 for the adult exceed the target HI of 1. The 95th percentile mean blood lead concentration in the resident child exposed to groundwater is 100 µg/dL, which is above the CDC target of 10 µg/dL. The following COCs were identified in groundwater for residents at the Blending/Shipping Area based on cancer and noncancer effects:

- antimony: groundwater ingestion HQ = 0.1 (child)
- arsenic: groundwater ingestion cancer risk = 4×10^{-5}
- lead: groundwater, 95th percentile mean blood lead level = 100 µg/dL
- manganese: groundwater ingestion HQ = 0.8 (child), 0.4 (adult)
- 2,4,6-trinitrotoluene: groundwater ingestion cancer risk = 8×10^{-4}
groundwater ingestion HQ = 200 (child), 100 (adult)
- 2,4-dinitrotoluene: groundwater ingestion cancer risk = 5×10^{-2}
groundwater ingestion HQ = 100 (child), 60 (adult)
- 2,6-dinitrotoluene: groundwater ingestion cancer risk = 3×10^{-4}
groundwater ingestion HQ = 2 (child), 0.8 (adult)
- 2-amino-4,6-dinitrotoluene: groundwater ingestion cancer risk = 5×10^{-5}
groundwater ingestion HQ = 0.1 (child)
- 4-amino-2,6-dinitrotoluene: groundwater ingestion cancer risk = 4×10^{-5}
groundwater ingestion HQ = 0.3 (child), 0.1 (adult)

Table 6-90. RME Risk Characterization Summary for Study Area GWC (Current/Future and Future Land Uses) Blending/Shipping Areas, Alabama Army Ammunition Plant, Childersburg, Alabama

Medium	Exposure Route	Cancer Risk: Industrial Worker	Cancer Risk: Construction Worker	Cancer Risk: Recreational Child	Cancer Risk: Recreational Adult	Cancer Risk: Residential Child	Cancer Risk: Residential Adult	Noncancer HI: Industrial Worker	Noncancer HI: Construction Worker	Noncancer HI: Recreational Child	Noncancer HI: Recreational Adult	Noncancer HI: Residential Child	Noncancer HI: Residential Adult
Surface Soil (0 to <1 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Subsurface Soil (1 to 10 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sediment	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface Water	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Groundwater	Ingestion	NA	NA	NA	NA	5E-02 E	5E-02 E	NA	NA	NA	NA	4E+02 E	2E+02 E
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	7E-07 B	7E-07 B	NA	NA	NA	NA	4E-02 B	2E-02 B
	Subtotal	NA	NA	NA	NA	5E-02 E	5E-02 E	NA	NA	NA	NA	4E+02 E	2E+02 E
Rabbit	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fish	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface Soil (0 to <1 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	NA	NA	NA	4E+02 E	2E+02 E
Combined Cancer Risk:		NA	NA	NA	NA	5E-02 E	5E-02 E						
Subsurface Soil (1 to 10 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	NA	NA	NA	4E+02 E	2E+02 E
Combined Cancer Risk:		NA	NA	NA	NA	5E-02 E	5E-02 E						

NA - pathway not evaluated or all detected chemicals eliminated as COPCs
0E+00 - pathway evaluated but no risks could be calculated due to lack of EPA-approved toxicity values
B - HI ≤ 1 or ELCR ≤ 10^{-4}
E - HI > 1 or ELCR > 10^{-4}

Table 6-91. Summary of Receptor Risks and Hazards for COCs at Study Area GWC
Reasonable Maximum Exposure
Blending/Shipping Areas, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Blending/Shipping Areas	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Antimony	--	--	--	--	Antimony	whole body, blood	0.104	--	--	0.104
			Arsenic	3.772E-05	--	--	3.772E-05	Arsenic	--	--	--	--	--
			Barium	--	--	--	--	Barium	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Copper	--	--	--	--	Copper	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	0.838	--	--	0.838
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			1,3-Dinitrobenzene	--	--	--	--	1,3-Dinitrobenzene	--	--	--	--	--
			2,4,6-Trinitrotoluene	0.000819	--	--	0.000819	2,4,6-Trinitrotoluene	liver	235	--	--	235
			2,4-Dinitrotoluene	0.0457	--	--	0.0457	2,4-Dinitrotoluene	CNS	148	--	--	148
			2,6-Dinitrotoluene	0.000307	--	--	0.000307	2,6-Dinitrotoluene	CNS, blood, kidney	1.94	--	--	1.94
			2-Amino-4,6-Dinitrotoluene	4.641E-05	--	--	4.641E-05	2-Amino-4,6-Dinitrotoluene	--	0.147	--	--	0.147
			4-Amino-2,6-Dinitrotoluene	4.293E-05	--	--	4.293E-05	4-Amino-2,6-Dinitrotoluene	--	0.271	--	--	0.271
			Carbon Tetrachloride	--	--	--	--	Carbon Tetrachloride	--	--	--	--	--
			Chloroform	--	--	--	--	Chloroform	--	--	--	--	--
			bis(2-Ethylhexyl)phthalate	--	--	--	--	bis(2-Ethylhexyl)phthalate	--	--	--	--	--
			(Total)	0.0469	--	--	0.0469	(Total)	--	386	--	--	386
	Air	Blending/Shipping Areas	Carbon Tetrachloride	--	--	--	--	Carbon Tetrachloride	--	--	--	--	--
			Chloroform	--	--	--	--	Chloroform	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--

Table 6-92. Summary of Receptor Risks and Hazards for COCs at Study Area GWC
Reasonable Maximum Exposure
Blending/Shipping Areas, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Blending/Shipping Areas	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Antimony	--	--	--	--	Antimony	--	--	--	--	--
			Arsenic	3.772E-05	--	--	3.772E-05	Arsenic	--	--	--	--	--
			Barium	--	--	--	--	Barium	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Copper	--	--	--	--	Copper	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	--	--	--	--
			Manganese	--	--	--	--	Manganese	CNS	0.359	--	--	0.359
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			1,3-Dinitrobenzene	--	--	--	--	1,3-Dinitrobenzene	--	--	--	--	--
			2,4,6-Trinitrotoluene	0.000819	--	--	0.000819	2,4,6-Trinitrotoluene	liver	101	--	--	101
			2,4-Dinitrotoluene	0.0457	--	--	0.0457	2,4-Dinitrotoluene	CNS	63	--	--	63
			2,6-Dinitrotoluene	0.000307	--	--	0.000307	2,6-Dinitrotoluene	CNS, blood, kidney	0.832	--	--	0.832
			2-Amino-4,6-Dinitrotoluene	4.641E-05	--	--	4.641E-05	2-Amino-4,6-Dinitrotoluene	--	--	--	--	--
			4-Amino-2,6-Dinitrotoluene	4.293E-05	--	--	4.293E-05	4-Amino-2,6-Dinitrotoluene	--	0.116	--	--	0.116
			Carbon Tetrachloride	--	--	--	--	Carbon Tetrachloride	--	--	--	--	--
			Chloroform	--	--	--	--	Chloroform	--	--	--	--	--
			bis(2-Ethylhexyl)phthalate	--	--	--	--	bis(2-Ethylhexyl)phthalate	--	--	--	--	--
			(Total)	0.0469	--	--	0.0469	(Total)	--	165	--	--	165
	Air	Blending/Shipping Areas	Carbon Tetrachloride	--	--	--	--	Carbon Tetrachloride	--	--	--	--	--
			Chloroform	--	--	--	--	Chloroform	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--

6.4.4.33 Groundwater – Smokeless Powder Area

Exposure to groundwater was evaluated only under the residential land use scenario. Residents were assumed to be exposed to groundwater through ingestion, dermal contact, and inhalation of volatile compounds. The RME risk characterization summary for groundwater at the Smokeless Powder Area is presented in **Table 6-93**, and COCs for each pathway and receptor are listed in **Tables 6-94** and **6-95**.

The maximum detected concentration of lead in groundwater at the Smokeless Powder Area exceeds the 15 µg/L screening level (EPA 1995c). Therefore, models were used to estimate blood lead levels in resident children.

Residential Scenario

The combined RME cancer risk for the integrated child or adult receptor is 3×10^{-2}, which exceeds the target cancer risk of 1×10^{-4}. The combined RME HIs of 100 for the child and 60 for the adult exceed the target HI of 1. The 95th percentile mean blood lead concentration in the resident child exposed to groundwater is 18 µg/dL, which is above the CDC target of 10 µg/dL. The following COCs were identified in groundwater for residents at the Smokeless Powder Area based on cancer and noncancer effects:

- arsenic: groundwater ingestion cancer risk = 7×10^{-5}
- iron: groundwater ingestion HQ = 6 (child), 2 (adult)
- lead: groundwater, 95th percentile mean blood lead level = 18 µg/dL
- manganese: groundwater ingestion HQ = 2 (child), 1 (adult)
- thallium: groundwater ingestion HQ = 0.5 (child), 0.2 (adult)
- 2,4,6-trinitrotoluene: groundwater ingestion cancer risk = 5×10^{-5}
groundwater ingestion HQ = 15 (child), 6 (adult)
- 2,4-dinitrotoluene: groundwater ingestion cancer risk = 3×10^{-2}
groundwater ingestion HQ = 100 (child), 50 (adult)
- 2,6-dinitrotoluene: groundwater ingestion cancer risk = 7×10^{-4}
groundwater ingestion HQ = 5 (child), 2 (adult)
- 2-amino-4,6-dinitrotoluene: groundwater ingestion cancer risk = 3×10^{-6}
- bis(2-ethylhexyl)phthalate: groundwater ingestion cancer risk = 3×10^{-6}

Table 6-93. RME Risk Characterization Summary for Study Area GWD (Current/Future and Future Land Uses) Smokeless Powder Area, Alabama Army Ammunition Plant, Childersburg, Alabama

Medium	Exposure Route	Cancer Risk: Industrial Worker	Cancer Risk: Construction Worker	Cancer Risk: Recreational Child	Cancer Risk: Recreational Adult	Cancer Risk: Residential Child	Cancer Risk: Residential Adult	Noncancer HI: Industrial Worker	Noncancer HI: Construction Worker	Noncancer HI: Recreational Child	Noncancer HI: Recreational Adult	Noncancer HI: Residential Child	Noncancer HI: Residential Adult
Surface Soil (0 to <1 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Subsurface Soil (1 to 10 ft BLS)	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sediment	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface Water	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Groundwater	Ingestion	NA	NA	NA	NA	3E-02 E	3E-02 E	NA	NA	NA	NA	1E+02 E	6E+01 E
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	4E-07 B	4E-07 B	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	3E-02 E	3E-02 E	NA	NA	NA	NA	1E+02 E	6E+01 E
Rabbit	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fish	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Subtotal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface Soil (0 to <1 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	NA	NA	NA	1E+02 E	6E+01 E
Combined Cancer Risk:		NA	NA	NA	NA	3E-02 E	3E-02 E						
Subsurface Soil (1 to 10 ft BLS), Sediment, Surface Water, Groundwater, Rabbits, and Fish													
Combined Hazard Index:								NA	NA	NA	NA	1E+02 E	6E+01 E
Combined Cancer Risk:		NA	NA	NA	NA	3E-02 E	3E-02 E						

NA - pathway not evaluated or all detected chemicals eliminated as COPCs
0E+00 - pathway evaluated but no risks could be calculated due to lack of EPA-approved toxicity values
B - HI $\leq$ 1 or ELCR $\leq 10^{-4}$
E - HI > 1 or ELCR > 10^{-4}

Table 6-94. Summary of Receptor Risks and Hazards for COCs at Study Area GWD
Reasonable Maximum Exposure
Smokeless Powder Area, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Smokeless Powder Area	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	7.442E-05	--	--	7.442E-05	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Hexavalent Chromium	--	--	--	--	Hexavalent Chromium	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	5.81	--	--	5.81
			Manganese	--	--	--	--	Manganese	CNS	2.23	--	--	2.23
			Mercury	--	--	--	--	Mercury	--	--	--	--	--
			Nickel	--	--	--	--	Nickel	--	--	--	--	--
			Thallium	--	--	--	--	Thallium	liver, blood	0.506	--	--	0.506
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			2,4,6-Trinitrotoluene	5.257E-05	--	--	5.257E-05	2,4,6-Trinitrotoluene	liver	15	--	--	15
			2,4-Dinitrotoluene	0.0329	--	--	0.0329	2,4-Dinitrotoluene	CNS	106	--	--	106
			2,6-Dinitrotoluene	0.000749	--	--	0.000749	2,6-Dinitrotoluene	CNS, blood, kidney	4.74	--	--	4.74
			2-Amino-4,6-Dinitrotoluene	2.830E-06	--	--	2.830E-06	2-Amino-4,6-Dinitrotoluene	--	--	--	--	--
			Chloroform	--	--	--	--	Chloroform	--	--	--	--	--
			bis(2-Ethylhexyl)phthalate	2.653E-06	--	--	2.653E-06	bis(2-Ethylhexyl)phthalate	--	--	--	--	--
			(Total)	0.0337	--	--	0.0337	(Total)	--	134	--	--	134
	Air	Smokeless Powder Area	Chloroform	--	3.640E-07	--	3.640E-07	Chloroform	--	--	--	--	--
			(Total)	--	3.640E-07	--	3.640E-07	(Total)	--	--	--	--	--

Table 6-95. Summary of Receptor Risks and Hazards for COCs at Study Area GWD
Reasonable Maximum Exposure
Smokeless Powder Area, Alabama Army Ammunition Plant, Childersburg, Alabama

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Smokeless Powder Area	Aluminum	--	--	--	--	Aluminum	--	--	--	--	--
			Arsenic	7.442E-05	--	--	7.442E-05	Arsenic	--	--	--	--	--
			Chromium, trivalent (assumed)	--	--	--	--	Chromium, trivalent (assumed)	--	--	--	--	--
			Chromium, hexavalent (assumed)	--	--	--	--	Chromium, hexavalent (assumed)	--	--	--	--	--
			Hexavalent Chromium	--	--	--	--	Hexavalent Chromium	--	--	--	--	--
			Iron	--	--	--	--	Iron	--	2.49	--	--	2.49
			Manganese	--	--	--	--	Manganese	CNS	0.957	--	--	0.957
			Mercury	--	--	--	--	Mercury	--	--	--	--	--
			Nickel	--	--	--	--	Nickel	--	--	--	--	--
			Thallium	--	--	--	--	Thallium	liver, blood	0.217	--	--	0.217
			Vanadium	--	--	--	--	Vanadium	--	--	--	--	--
			2,4,6-Trinitrotoluene	5.257E-05	--	--	5.257E-05	2,4,6-Trinitrotoluene	liver	6.46	--	--	6.46
			2,4-Dinitrotoluene	0.0329	--	--	0.0329	2,4-Dinitrotoluene	CNS	45	--	--	45
			2,6-Dinitrotoluene	0.000749	--	--	0.000749	2,6-Dinitrotoluene	CNS, blood, kidney	2.03	--	--	2.03
			2-Amino-4,6-Dinitrotoluene	2.830E-06	--	--	2.830E-06	2-Amino-4,6-Dinitrotoluene	--	--	--	--	--
			Chloroform	--	--	--	--	Chloroform	--	--	--	--	--
			bis(2-Ethylhexyl)phthalate	2.653E-06	--	--	2.653E-06	bis(2-Ethylhexyl)phthalate	--	--	--	--	--
			(Total)	0.0337	--	--	0.0337	(Total)	--	--	--	--	--
	Air	Smokeless Powder Area	Chloroform	--	--	--	--	Chloroform	--	--	--	--	--
			(Total)	--	--	--	--	(Total)	--	--	--	--	--

6.5 UNCERTAINTY

Uncertainty is inherent in the selection of key input parameters and in every step of the risk assessment process. The results of risk assessment may be understood only in light of the assumptions and methods used in the evaluation. The sources of uncertainty in the baseline human health risk assessment and the relative influence of these sources on the risk assessment results are discussed in the following subsections and summarized in **Table 6-96**. In keeping with EPA guidance (EPA 1989a), the table is a qualitative (order of magnitude) assessment incorporating simple relative influences of principal sources of uncertainty on the overall results of risk assessment.

6.5.1 Analytical Data

Uncertainty will always surround estimates of environmental concentrations at waste sites. Uncertainty in the analytical data may be linked to sample density and distribution, collection procedures in the field, seasonal fluctuations, and accuracy of the sample analyses.

Procedures relating to sample collection were established to reduce uncertainty surrounding sample results. Standard QA/QC measures (e.g., proper decontamination of equipment and collection of trip blanks, field blanks, and matrix spike/matrix spike duplicates [MS/MSDs]) were followed to reduce uncertainty associated with the analytical data. The uncertainty associated with sample collection procedures has the potential for either over or underestimating risks to receptors.

Uncertainty also may be introduced at the laboratory. Standardized procedures are followed by the laboratory to reduce this uncertainty. For example, these procedures include the use of surrogate spikes to monitor chemical recovery, internal standards to monitor instrument sensitivity, and laboratory blanks to determine if laboratory preparation has introduced contamination to the sample. These measures are explained in the data quality assessment (Appendix I).

Instances may arise in which the detection limits for certain chemicals are above their RBCs. Therefore, there is uncertainty regarding the potential health effects of these chemicals when detected below their detection limits but above the RBCs. When chemicals are detected below their detection limits, the concentration is flagged as estimated because the concentration may not be accurate (due to instrument limitations). There is no consistent direction to the bias (i.e., the reported concentration may underestimate or overestimate the actual concentration).

One surface water and one sediment sample were collected from an area of ponded drainage at Study Area 16. In lieu of additional data, risks were calculated for the one sample to determine if the observed chemical concentrations pose adverse health effects to human receptors. However, it is important to recognize that there are significant limitations in using one sample to characterize the nature and extent of contamination (if any is present) or the average exposure point concentration to

Table 6-96. Qualitative Uncertainty Estimates
Alabama Army Ammunition Plant, Childersburg, Alabama

Assumptions	Effect on risk estimates		
	Potential for overestimating risk	Potential for underestimating risk	Potential for over or underestimating risk
Environmental Sampling and Analysis			
Samples collected are representative of contamination (e.g., sufficient density and distribution)			Medium
Precision and accuracy of chemical analysis		Low	
Exposure Assessment			
Likelihood of exposure scenarios occurring	Medium		
Contact, uptake, and absorption rates are representative of exposed populations	Low to Medium		
Models accurately predict movements and concentrations of contaminants			Low
Assumption that chemicals do not transform or degrade over time	Low		
Toxicity assessment			
Use of EPA-verified RfDs and cancer slope factors	Medium		
Quantitative evaluation that is not performed for chemicals which do not have EPA-verified toxicity values		Medium	
Use of GI absorption factors to adjust oral administered toxicity values for evaluation of dermal contact pathway			Medium
Use of equivalency factors for PAHs			Medium
Risk Characterization			
Likelihood that receptors under evaluation are actually at risk	Medium		
Assumption of additivity of toxic effects			Medium

which human receptors are exposed. Use of limited data sets could result in underestimates or overestimates of hazard or risk. Nevertheless, the analysis was conducted to provide some degree of evidence regarding the significance of the observed sample data.

6.5.2 Exposure Assessment

The following types of uncertainty have been identified regarding the exposure assessment:

- ***Scenario Uncertainty***—Missing or incomplete information needed to define the exposure scenario or pathway
- ***Model Uncertainty***—Inability to quantify all assumptions in model variables
- ***Parameter Uncertainty***—Inadequate information to quantify an exposure variable or parameter.

Scenario uncertainty arises when pathways were not included in, or were eliminated from, the assessment. The pathways that were included in the human health risk assessment and corresponding rationale are presented in Section 6.2.2. A future residential scenario has been evaluated for ALAAP. Residential conversion of Area B is unlikely because the Army has selected the industrial scenario as the future reuse (USAEC 1995b). Therefore, the inclusion of the residential scenario is most likely conservative.

Assumptions about the future land uses are speculative. In attempting to predict future exposures, assumptions must be made concerning contaminant fate and transport, future site activities, and receptor behavior. In particular, it was conservatively assumed that contaminant concentrations will be the same in the future as at present.

Model uncertainty may arise in cases where site-specific sample data are unavailable to confirm the model. For example, the LEAD 0.99d biokinetic model was used to predict blood lead levels in children. Without high-quality blood samples from children, it is impossible to verify that the LEAD 0.99d model accurately predicts uptake of lead into children.

Parameter uncertainty results partly because many of the exposure parameters (i.e., exposure factors) used in the risk assessment are default values recommended by EPA. These default parameters, which are generally conservative, do not necessarily reflect actual behavior and have been used in the absence of site-specific information.

The exposure frequency for ingestion of fish is 120 days per year. This is a reasonable value based on general study data because site-specific values were not available. The fraction ingested (FI) term was assumed to be one, indicating that all fish consumed by a receptor is from Area B. Assuming an FI of one is a conservative assumption because it is likely that the majority of fish consumed by a receptor comes from sources other than Area B (i.e., a grocery store, fishing from

other water bodies). At Area B, the upper portions of the ditches are dry for three to six months of the year and support only small fish due to the small stream size. Although there is more water and bigger fish present in the lower ditches, access is generally more difficult due to fallen debris, overgrowth, and snakes. The Beaver Ponds are perennial, but shrink during the dry months.

Exposure parameters are commonly treated as single point estimates and are used in the exposure equations to calculate a single estimate for exposure and risk. These parameters are usually not single values, but are averages, best estimates, or high-end estimates taken from a range of values. For example, some individuals in a population may be more active than others and some may have greater body weights than others.

A range of values that often can be represented by a distribution more accurately represents the exposure parameters. If distributions are used for the exposure parameters, the result is a distribution for the estimate of exposure. The distribution of the exposure estimate represents the *variability* of the exposures that may exist within an exposed population; in other words, some individuals are more highly exposed than others.

Individual estimates within the variability distribution may be *uncertain*. For example, some of the exposure parameters used in the intake equation may be based on measurements that are inaccurate. Information gained by observation or through interviews may be biased or otherwise flawed. There also is uncertainty in the toxicity values used to estimate risk for humans, which are often extrapolated from the results of experiments that were conducted on animals.

In current CERCLA-style risk assessments, three methods have emerged that are used in the analysis of uncertainty: qualitative discussions, multiple deterministic estimates, and continuous probabilistic estimates. Of these, the probabilistic approach has been used successfully to quantitatively distinguish between variability and uncertainty.

Qualitative discussions are necessary to some degree in all uncertainty analyses. In many cases, sole reliance on either a qualitative or a semi-quantitative approach provides risk managers with enough information to make informed decisions.

Multiple deterministic estimates are simply two or more point estimates that in conjunction define a range. This is the approach to uncertainty used in this risk assessment. When single point estimates are used, EPA specifies that the resulting risk estimate should be demonstrably conservative. This conservative estimate is the RME. CTE estimates have been presented along with the RME estimates. The CTE consists of average parameters, rather than the mixture of average and high end parameters used in the RME estimate. When viewed together, risk managers are given an indication that an RME estimate may or may not be adequately conservative.

Probabilistic techniques are available for quantitatively assessing exposure parameters and their effect on exposure estimates. Probabilistic approaches produce a continuous range of exposure (or risk) estimates for percentiles of the population of concern. For example, the risk for the 28th

percentile of the exposed population can be distinguished using a probabilistic simulation. Typically, there is no attempt to separate variability from uncertainty when using these techniques.

Recently, efforts have been made by risk assessors to account for the effect that variability and uncertainty may have on the final risk estimates. The methods consist of evaluating whether variability, uncertainty, or a combination of the two are most important in terms of effect on the risk estimates. If either variability or uncertainty dominate, the dominating component may be probabilistically analyzed for the effect on the risk estimates. If both variability and uncertainty are important, they are statistically disaggregated from one another to evaluate the relative effect of each. In either case, conventional probabilistic simulations, such as Monte Carlo or Latin hypercube sampling, may be used. Probabilistic techniques are the most resource-intensive methods for dealing with uncertainty and were not used in this risk assessment.

6.5.3 Toxicity Data

Although EPA provides toxicity values that are point estimates, a significant amount of uncertainty surrounds these point estimates. Identification of the sources of this uncertainty enables the risk assessor to establish the degree of confidence associated with the toxicity measures.

Uncertainty is inherent within the toxicity assessment and is primarily due to differences in study design, species, sex, routes of exposure, or dose-response relationships. A major source of uncertainty involves the use of toxicity values based on experimental studies that substantially differ from typical human exposure scenarios. The derivation of the toxicity values must take into account such differences as using dose-response information from animal studies to predict effects in humans; using dose-response information from high-dose studies to predict adverse health effects from low doses; using data from short-term studies to predict long-term (chronic) effects; and extrapolating from specific populations to general populations.

The CSFs, in particular, are based on studies that may differ greatly from realistic situations. Experimental cancer bioassays typically expose animals to very high levels of chemicals (i.e., the maximum tolerated dose) for their entire lifetime. After the appropriate studies have been identified, the slope factor is calculated as the UCL_{95} of the slope of the dose-response curve. This introduces conservatism into the risk assessment.

The derivation of RfDs generally involves the use of animal studies. Uncertainty factors ranging from 1 to 10,000 are incorporated into the RfD to provide an extra level of public health protection. The factors used depend on the type of study from which the value has been derived (e.g., animal or human, long-term or short-term). The scientific basis for this practice is somewhat uncertain. In general, high uncertainty factors are meant to bias the results conservatively so that exposures at the RfD level will not result in adverse health effects.

Toxicity values are not available from EPA for the dermal route. Therefore, oral toxicity values were adjusted for the dermal pathway by using chemical-specific gastrointestinal absorption

factors to adjust the oral toxicity value from an administered value to an absorbed value. When adjusted to an absorbed value, the value may then appropriately be used to evaluate dermally absorbed doses.

For some chemicals, chemical-specific gastrointestinal absorption factors are not available. In such cases, default absorption factors were used to evaluate the dermal pathway (EPA 1995c). This introduces uncertainty into the risk assessment that varies for different chemicals and could either over or underestimate risk.

In addition, no adjustments were made for the medium of exposure (e.g., when the medium of exposure at the study area differs from the medium of exposure assumed by the laboratory study from which the toxicity value was derived). The uncertainty associated with using the absorbed dose toxicity values for the dermal pathway is moderate and the bias unknown.

There are many chemicals for which no toxicity value exists and for which little information is available. Therefore, a quantitative risk estimate cannot be calculated for these chemicals. For example, many chemicals are not evaluated for the inhalation pathway because of limited inhalation-based toxicological information. The lack of toxicity information for some chemicals may contribute to the underestimation of risks.

Toxicity values are not available for most of the PAH compounds. Only one carcinogenic PAH (benzo(a)pyrene) has a toxicity value for use in risk assessment. When evaluating exposure to PAHs, the approach used in the risk assessment was to relate the concentration of PAHs to that of benzo(a)pyrene. The factors used to relate the concentrations are called TEFs. This approach, although currently under review by EPA, is based on scientific studies, and is thought to be more realistic than the alternative method of assuming that all carcinogenic PAHs have a toxicity equivalence factor equal to that of benzo(a)pyrene.

Iron was identified as a COC at many of the Area B study areas. However, iron is not believed to be a toxicological concern at Area B. The HQ associated with iron is based on a provisional toxicity value issued by the NCEA. There is considerable uncertainty surrounding this toxicity value with a bias toward conservatism. The provisional toxicity value is based upon the documented toxicity of pharmaceutical iron supplements to young children. It is therefore uncertain in terms of its application to iron in environmental media. A measure of the level of significance of the iron concentrations at Area B is the FDA DV for iron of 18 mg per day. Using the exposure factors from the risk assessment, the DV is roughly comparable to a soil concentration of 180,000 mg/kg for a 70 kg adult (see Appendix M for calculation). Almost all of the soil concentrations at Area B are well below this concentration. Note also that the daily value is a recommended daily amount of dietary iron for proper nutrition, not a toxic threshold. Therefore, concentrations above this concentration do not necessarily indicate adverse health effects.

6.5.4 Multiple Chemical Exposures

Uncertainties in any phase of the risk analysis are reflected in the risk estimates. Some uncertainty is associated with the summation of risks and HQs for multiple chemical contaminants. As stated in RAGS (EPA 1989a), "The assumption of dose additivity ignores possible synergisms or antagonisms among chemicals, and assumes similarity in mechanisms of action and metabolism."

Cancer and noncancer risks are summed in the risk characterization process (separately for carcinogens and noncarcinogens) to estimate potential risks associated with the simultaneous exposure to multiple chemicals. In the case of carcinogens, this approach gives chemicals that are probable human carcinogens (based on animal data or limited human data) the same weight as chemicals that are known human carcinogens. It also equally weighs CSFs derived from animal data with those derived from human data. Uncertainties in the combined risks also are compounded because RfDs and CSFs do not have equal accuracy or levels of confidence and are not based on the same severity of effect. These methods may over or underestimate the actual risk.

For noncancer effects, if the pathway HI exceeds 1, chemicals are segregated according to which organ they target, and the pathway HI is recalculated. Chemicals contributing to TOHIs less than or equal to 1 are eliminated as COCs. This segregation contributes to the uncertainty inherent within the risk assessment results. Particularly, there is concern that where multiple chemical exposures are involved, this practice may underestimate hazards. Chemicals have been segregated according to the primary organ(s) which they target. In some cases, there may be secondary organs that are targeted depending on the dose and circumstances surrounding the receptor's exposure.

6.5.5 Central Tendency Exposure Estimates

In accordance with EPA Region IV guidance (EPA 1995c), risks were calculated for both RME and CTE risk scenarios. The CTE risk calculations and summary tables are presented in Appendix M and are summarized in this section. **Table 6-97** presents the COCs identified using CTE exposure scenarios. This table can be compared to the corresponding RME table (**Table 6-98**) and used to illustrate how COCs and study areas needing remediation under an RME scenario would differ if remediation were based on the CTE risks.

6.6 SUMMARY

The purpose of the baseline human health risk assessment is to assess the potential for adverse health effects to humans resulting from contact with contaminants identified at the study areas under investigation. The risk assessment provides a health-based rationale that, along with other factors developed during the investigation, is used to decide whether or not and to what extent to remediate.

Table 6-97. COCs for CTE Risks at ALAAP, Area B
Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area	Medium	Land Use								Exceedance of MCL[a]
		Current/Future Industrial	Future Recreational	Future Residential	surf	subs	Future Construction	surf	subs	
2 - Smokeless Powder Facility	soil			arsenic	x					
				manganese	x	x				
				benzo(a)anthracene	x					
				benzo(a)pyrene	x					
				benzo(b)fluoranthene	x					
				dibenzo(a,h)anthracene	x					
				2,4-dinitrotoluene		x				
				indeno(1,2,3-cd)pyrene	x					
3 - Sanitary Landfill and Lead Facility	soil									
4 - Manhattan Project Area	soil			lead	x	x	lead	x		
5 - Red Water Storage Basin										
6 - Southern TNT Manufacturing Area										
7 - Northern TNT Manufacturing Area	soil			manganese		x				
8 - Acid/Organic Manufacturing Area	soil			lead		x				
				manganese	x	x				
				nickel	x					
8 - Test pits	soil			iron		x	iron		x	
9 - Aniline Sludge Basin	sediment									
9 - Tar	tar			lead	x					
			N-nitrosodiphenylamine	N-nitrosodiphenylamine	x					
9 - Sediments beneath tar										
10 East - Tetryl Manufacturing Area	soil	manganese		manganese	x	x	manganese	x		
10 West - Tetryl Manufacturing Area										
16 - Flashing Ground	soil									
17 - Propellant Shipping Area	soil			manganese	x					
18 - Blending Tower Area	soil			manganese	x	x				
19 - Lead Facility	soil									
20 - Rifle Powder Finishing Area	soil									
21 - Red Water Ditch	fish		arsenic	arsenic						
			Aroclor 1254	Aroclor 1254						

Table 6-97. COCs for CTE Risks at ALAAP, Area B (Continued)
Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area	Medium	Land Use								Exceedance of MCL[a]
		Current/Future Industrial	Future Recreational	Future Residential	surf	subs	Future Construction	surf	subs	
22 - Demolition Landfill	soil			arsenic		x	arsenic		x	
				chromium, hexavalent		x				
				benzo(a)anthracene		x	benzo(a)anthracene		x	
				benzo(a)pyrene		x	benzo(a)pyrene		x	
				benzo(b)fluoranthene		x	benzo(b)fluoranthene		x	
				benzo(k)fluoranthene		x	benzo(k)fluoranthene		x	
				dibenzo(a,h)anthracene		x	dibenzo(a,h)anthracene		x	
				indeno(1,2,3-cd)pyrene		x	indeno(1,2,3-cd)pyrene		x	
25 - Storage Battery/Demolition Debris	soil									
26 - Crossover Ditch	fish			mercury						
27 - Beaver Pond Drainage System										
Building 6 - Coke Oven	soil									
Transformer Storage Building and Utility Poles	soil			Aroclor 1254	x					
Underground Storage Tanks	soil			manganese		x				
Gas Station										
Fertilizer and Pesticide Storage	soil			manganese		x				
Talladega Creek										
Coosa River										
Study Areas 16 and 19	groundwater									lead
				manganese						
				2,4,6-trinitrotoluene						
				2,4-dinitrotoluene						
				4-amino-2,6-dinitrotoluene						
										pentachlorophenol
										bis(2-ethylhexyl)phthalate

Table 6-97. COCs for CTE Risks at ALAAP, Area B (Continued)
Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area	Medium	Land Use								Exceedance of MCL[a]
		Current/Future Industrial	Future Recreational	Future Residential	surf	subs	Future Construction	surf	subs	
Main Industrial Area	groundwater			arsenic iron lead manganese thallium 2,4,6-trinitrotoluene 2,4-dinitrotoluene 2,6-dinitrotoluene 2-amino-4,6-dinitrotoluene 4-amino-2,6-dinitrotoluene pentachlorophenol vinyl chloride						arsenic beryllium lead nickel carbon tetrachloride pentachlorophenol vinyl chloride bis(2-ethylhexyl)phthalate
Blending/Shipping Area	groundwater			arsenic lead manganese 2,4,6-trinitrotoluene 2,4-dinitrotoluene 2,6-dinitrotoluene 2-amino-4,6-dinitrotoluene 4-amino-2,6-dinitrotoluene						lead bis(2-ethylhexyl)phthalate
Smokeless Powder Area	groundwater			arsenic iron lead manganese thallium 2,4,6-trinitrotoluene 2,4-dinitrotoluene 2,6-dinitrotoluene						lead nickel bis(2-ethylhexyl)phthalate

[a]Includes both State and Federal MCLs

Table 6-98. COCs for RME Risks at ALAAP, Area B
Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area	Medium	Land Use								Exceedance of MCL[a]
		Current/Future Industrial	Future Recreational	Future Residential	surf	subs	Future Construction	surf	subs	
2 - Smokeless Powder Facility	soil									
		arsenic	arsenic	arsenic	x		arsenic	x		
				chromium, hexavalent	x					
				iron	x	x				
				manganese	x	x				
		benzo(a)anthracene	benzo(a)anthracene	benzo(a)anthracene	x		benzo(a)anthracene	x		
		benzo(a)pyrene	benzo(a)pyrene	benzo(a)pyrene	x	x	benzo(a)pyrene	x		
		benzo(b)fluoranthene	benzo(b)fluoranthene	benzo(b)fluoranthene	x	x	benzo(b)fluoranthene	x		
		benzo(k)fluoranthene		benzo(k)fluoranthene	x					
		dibenzo(a,h)anthracene	dibenzo(a,h)anthracene	dibenzo(a,h)anthracene	x		dibenzo(a,h)anthracene	x		
				2,4-dinitrotoluene		x				
		indeno(1,2,3-cd)pyrene	indeno(1,2,3-cd)pyrene	indeno(1,2,3-cd)pyrene	x		indeno(1,2,3-cd)pyrene	x		
3 - Sanitary Landfill and Lead Facility	soil			arsenic	x					
				iron	x	x				
				manganese		x				
4 - Manhattan Project Area	soil			lead	x	x	lead	x		
5 - Red Water Storage Basin										
6 - Southern TNT Manufacturing Area										
7 - Northern TNT Manufacturing Area	soil			manganese		x				
				2,4,6-trinitrotoluene		x				
8 - Acid/Organic Manufacturing Area	soil			arsenic	x					
				iron	x	x				
				lead		x				
				manganese	x	x				
				nickel	x		nickel	x		
				benzo(a)anthracene	x					
				benzo(a)pyrene	x					
				benzo(b)fluoranthene	x					
				dibenzo(a,h)anthracene	x					
				indeno(1,2,3-cd)pyrene	x					
8 - Test pits	soil			antimony		x				
				arsenic		x				
				iron		x	iron		x	

Table 6-98. COCs for RME Risks at ALAAP, Area B (Continued)
Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area	Medium	Land Use								Exceedance of MCL[a]
		Current/Future Industrial	Future Recreational	Future Residential	surf	subs	Future Construction	surf	subs	
9 - Aniline Sludge Basin	sediment			iron	x					
9 - Tar	tar			iron	x					
				lead	x					
			N-nitrosodiphenylamine	N-nitrosodiphenylamine	x					
9 - Sediments beneath tar										
10 East - Tetryl Manufacturing Area	soil			iron	x	x				
		manganese		manganese	x	x	manganese	x		
10 West - Tetryl Manufacturing Area				lead	x					
16 - Flashing Ground	soil			arsenic	x					
				iron	x					
				lead	x	x	lead	x		
				benzo(a)anthracene	x					
				benzo(a)pyrene	x					
				benzo(b)fluoranthene	x					
				dibenzo(a,h)anthracene	x					
				indeno(1,2,3-cd)pyrene	x					
				2,4,6-trinitrotoluene		x				
17 - Propellant Shipping Area	soil			arsenic	x	x				
				iron	x					
				manganese	x	x	manganese	x		
18 - Blending Tower Area	soil			arsenic	x					
				iron	x					
				manganese	x	x				
19 - Lead Facility	soil			arsenic		x				
20 - Rifle Powder Finishing Area	soil			iron		x				
21 - Red Water Ditch	fish		arsenic	arsenic						
			Aroclor 1254	Aroclor 1254						

Table 6-98. COCs for RME Risks at ALAAP, Area B (Continued)
Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area	Medium	Land Use								Exceedance of MCL[a]
		Current/Future Industrial	Future Recreational	Future Residential	surf	subs	Future Construction	surf	subs	
22 - Demolition Landfill	soil			arsenic		x	arsenic		x	
				chromium, hexavalent		x				
				iron		x				
		lead		lead	x	x	lead	x	x	
				manganese		x				
				benzo(a)anthracene		x	benzo(a)anthracene		x	
				benzo(a)pyrene		x	benzo(a)pyrene		x	
				benzo(b)fluoranthene		x	benzo(b)fluoranthene		x	
				benzo(g,h,i)perylene		x				
				benzo(k)fluoranthene		x	benzo(k)fluoranthene		x	
				chrysene		x				
				dibenzo(a,h)anthracene		x	dibenzo(a,h)anthracene		x	
				indeno(1,2,3-cd)pyrene		x	indeno(1,2,3-cd)pyrene		x	
25 - Storage Battery/Demolition Debris	soil			iron	x					
				manganese		x				
26 - Crossover Ditch	fish			mercury						
27 - Beaver Pond Drainage System										
Building 6 - Coke Oven	soil			arsenic		x				
				iron	x	x				
				manganese		x				
Transformer Storage Building and Utility Poles	soil	Aroclor 1248		Aroclor 1248	x					
		Aroclor 1254		Aroclor 1254	x		Aroclor 1254	x		
		Aroclor 1260		Aroclor 1260	x					
Underground Storage Tanks	soil			iron		x				
				manganese		x				
Gas Station										
Fertilizer and Pesticide Storage	soil			iron	x	x	iron		x	
				manganese		x				
Talladega Creek										
Coosa River										

Table 6-98. COCs for RME Risks at ALAAP, Area B (Continued)
Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area	Medium	Land Use				Exceedance of MCL[a]
		Current/Future Industrial	Future Recreational	Future Residential surf subs	Future Construction surf subs	
Areas 16 and 19	groundwater			iron		
						lead
				manganese		
				2,4,6-trinitrotoluene		
				2,4-dinitrotoluene		
				2,6-dinitrotoluene		
				2-amino-4,6-dinitrotoluene		
				4-amino-2,6-dinitrotoluene		
				pentachlorophenol		pentachlorophenol
				RDX		
				bis(2-ethylhexyl)phthalate		bis(2-ethylhexyl)phthalate
Main Industrial Area	groundwater			arsenic		arsenic
						beryllium
				iron		
				lead		lead
				manganese		
						nickel
				thallium		
				2,4,6-trinitrotoluene		
				2,4-dinitrotoluene		
				2,6-dinitrotoluene		
				2-amino-4,6-dinitrotoluene		
				4-amino-2,6-dinitrotoluene		
				benzo(a)pyrene		
				benzo(b)fluoranthene		
						carbon tetrachloride
				nitrobenzene		
				pentachlorophenol		pentachlorophenol
				RDX		
				vinyl chloride		vinyl chloride
				bis(2-ethylhexyl)phthalate		bis(2-ethylhexyl)phthalate

Table 6-98. COCs for RME Risks at ALAAP, Area B (Continued)
Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area	Medium	Land Use				Exceedance of MCL[a]
		Current/Future Industrial	Future Recreational	Future Residential (surf / subs)	Future Construction (surf / subs)	
Blending/Shipping Area	groundwater			antimony arsenic lead manganese 2,4,6-trinitrotoluene 2,4-dinitrotoluene 2,6-dinitrotoluene 2-amino-4,6-dinitrotoluene 4-amino-2,6-dinitrotoluene		lead bis(2-ethylhexyl)phthalate
Smokeless Powder Area	groundwater			arsenic iron lead manganese thallium 2,4,6-trinitrotoluene 2,4-dinitrotoluene 2,6-dinitrotoluene 2-amino-4,6-dinitrotolune bis(2-ethylhexyl)phthalate		lead nickel bis(2-ethylhexyl)phthalate

Modified COCs (MCOCs) are COCs retained after the weight of evidence evaluation.

[a]Includes both State and Federal MCLs

Noncancer and cancer risks to humans were estimated for both current and future land uses. The scenarios evaluated in the risk assessment are current and future industrial land use, future recreational land use, future residential land use, and future construction land use. The most likely future land use of Area B is industrial, according to the Site Management Plan prepared by USAEC for ALAAP (USAEC 1995b).

In the risk assessment, COCs are identified as chemicals that exceed EPA targets (Section 6.4.4) and chemicals that exceed ARARs (Section 6.1.2). The COCs based on RME risks for Area B are presented in Table 6-98 according to land use and exposure unit.

6.6.1 Current and Future Industrial Land Use

Risks for soil exposure exceeded EPA targets (noncancer HI of 1, cancer risk of 1×10^{-4}, blood lead level greater than the CDC guideline) at four study areas: Study Areas 2, 10–East, 22, and the Transformer Storage Building and Utility Poles. The COCs at these study areas include metals, PCBs, and PAHs. Surface water, sediment, biota, and groundwater exposures were not evaluated under the industrial land use scenario.

6.6.2 Future Recreational Land Use

Risks exceeded EPA targets (noncancer HI of 1, cancer risk of 1×10^{-4}, blood lead level greater than the CDC guideline) at three study areas: Study Areas 2 (soil), 9 (tar), and 21 (fish). The COCs at these study areas include SVOCs, metals, and PCBs. Risks from exposure to surface water and sediment were below EPA targets. Groundwater exposures were not evaluated under the recreational land use scenario.

6.6.3 Future Residential Land Use

Risks exceeded EPA targets (noncancer HI of 1, cancer risk of 1×10^{-4}, blood lead level greater than the CDC guideline) at 18 study areas. The COCs at these study areas include explosives, metals, PCBs, and PAHs, as shown in Table 6-98. Risks from ingestion of fish tissue exceeded EPA targets at Study Areas 21 and 26. Risks from exposure to surface water and sediment were below EPA targets except for sediment at Study Area 9. Groundwater risks exceeded EPA targets for all exposure units.

6.6.4 Future Construction Land Use

Risks for soil exposure exceeded EPA targets (noncancer HI of 1, cancer risk of 1×10^{-4}, blood lead level greater than the CDC guideline) at nine study areas: Study Areas 2, 4, 8, 10, 16, 17, 22, the Transformer Storage Building and Utility Poles, and the Fertilizer and Pesticide Storage Building. The COCs at these study areas include metals, PCBs, and PAHs. Surface water, sediment, biota, and groundwater exposures were not evaluated under the construction land use scenario.

6.6.5 Discussion of the COCs

In soil and groundwater, explosives pose the risk of adverse health effects, with noncancer effects dominating. Explosives of the type found at Area B are rapidly absorbed into the body. Much of what is known about the toxicity of these chemicals is based on studies conducted in occupational settings with the explosives themselves, not on soils contaminated with these chemicals. The soil at ALAAP is likely to have a modifying effect on the toxicity of the explosives, and it may be reasonable to expect less toxicity when they are mixed with soil. The magnitude of the risks for the explosives nevertheless is a cause for concern. Oral and dermal contact with contaminated soil or groundwater may result in adverse health effects if the potential for exposure is not restricted, either by remediation or by access restrictions.

Lead was identified as a problem in soil and in groundwater for both children and adults. A strong correlation exists between increasing uptake of lead with increasing soil concentrations. In general, lead toxicity tends to be more pronounced and serious in children than adults. Lead, however, is associated with reproductive disorders and can accumulate in the body's bone tissue over time. These results suggest that there may be a need to minimize the potential for exposure to lead at Area B.

PAHs (i.e., benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene) typically are byproducts of incomplete combustion. These substances are carcinogenic. Relatively high levels of PAHs could have originated from industrial processes or even more likely from the burning that occurred at ALAAP. During the 1980s, many of the wooden frame buildings were demolished using flame throwers to set fire to the buildings. Because Study Area 22 received demolition debris, partially burned debris could account for the PAHs. The PAHs are COCs in soil, not in groundwater. This most likely reflects their low water solubility and high affinity for soil. Therefore, it is reasonable to expect that these PAHs are unlikely to become COCs in groundwater at ALAAP.

PCBs (Aroclor-1248, Aroclor-1254, and Aroclor-1260) were identified as COCs in soils at the Transformer Storage Building and Utility Poles. PCBs are most likely related to the presence of electrical transformers that were stored in the area, and presumably were leaking PCB-contaminated oil. The health effect of concern for exposure to PCBs is cancer. The PCB contamination is limited to soils in this study area. The hydrophobic and covalent binding properties of PCBs indicate that migration to the groundwater at ALAAP is highly unlikely.

6.7 REMEDIAL GOAL OPTIONS BASED ON HUMAN HEALTH RISK

After the identification of the COCs, human health remedial goal options (HHRGOs) were calculated. The HHRGOs are estimates of protective cleanup levels based on risk to human receptors. In the FS, HHRGOs, ecological RGOs (based on risk to ecological receptors), and ARARs are all considered in the selection of the final cleanup levels. Remediation activity at the site will be conducted to meet the final cleanup levels.

In accordance with EPA Region VI guidance (EPA 1995c), HHRGOs were calculated for all COCs identified in the human health risk assessment (i.e., chemicals that exceed ARARs or contribute to a pathway that exceeds a hazard index of 1 or a cancer risk of 1×10^{-4}). The HHRGOs are not unique to a given study area. Rather, they are unique to a given receptor and medium. They take into consideration exposure from multiple pathways (the same pathways that are evaluated in the risk assessment). For example, a soil HHRGO takes into account risks from soil ingestion, dermal contact with soil, and inhalation of suspended soil particulates.

EPA Region IV has provided guidance for deriving HHRGOs (EPA 1995c). They are calculated using an equation that is similar to the intake equation, setting the cancer risk or noncancer HI to the appropriate target, and solving the equation for the concentration term. In accordance with EPA Region IV guidance, HHRGOs are calculated using noncancer target HIs of 0.1, 1, and 3 and target cancer risks of 10^{-6}, 10^{-5}, and 10^{-4}. Therefore, multiple HHRGOs are calculated for a given receptor and medium. These calculations use EPA-approved toxicity values and exposure assumptions from the risk assessment. The HHRGOs for Area B are presented in **Tables 6-99** and **6-100**.

Table 6-99. Remedial Goal Options: Soil (Ingestion, Dermal Contact, and Inhalation of Dust)
Alabama Army Ammunition Plant, Childersburg, Alabama

	Noncarcinogenic Effects							Carcinogenic Effects				
				Recreational		Residential					Recreational	Residential
Chemical	Target Hazard Index	Industrial Worker	Construction Worker	Child	Adult	Child	Adult	Target Cancer Risk	Industrial Worker	Construction Worker	Integrated Child/Adult	Integrated Child/Adult
INORGANICS (µg/g)												
Antimony	0.1	12	5.3	43	52	2.1	10	1E-06	No CSF	No CSF	No CSF	No CSF
Arsenic	0.1	48	6.2	90	134	2.3	155	1E-06	2.7	4.8	5.2	0.39
Hexavalent Chromium	0.1	77	37	288	369	14	63	1E-06	13	135	77	5.1
Iron	0.1	34,579	5,911	77,395	110,553	2,199	56,638	1E-06	No CSF	No CSF	No CSF	No CSF
Lead	0.1	No RfD/RfC**	No RfD/RfC**	No RfD/RfC	No RfD/RfC	400**	400**	1E-06	No CSF**	No CSF**	No CSF	400**
Manganese	0.1	223	143	995	1,877	40	167	1E-06	No CSF	No CSF	No CSF	No CSF
Nickel	0.1	2,859	408	5,704	8,413	151	6,797	1E-06	No CSF	No CSF	No CSF	No CSF
ORGANICS (µg/g)												
2,4,6-Trinitrotoluene	0.1	35	8.9	98	130	3.3	38	1E-06	65	207	162	15
2,4-Dinitrotoluene	0.1	173	37	443	607	14	214	1E-06	3.6	10	8.3	0.73
Aroclor-1248	0.1	No RfD/RfC	No RfD/RfC	No RfD/RfC	No RfD/RfC	No RfD/RfC	No RfD/RfC	1E-06	1.3	3.3	2.9	0.25
Aroclor-1254	0.1	1.8	0.80	4.5	6.2	0.14	2.3	1E-06	1.3	3.3	2.9	0.25
Aroclor-1260	0.1	No RfD/RfC	No RfD/RfC	No RfD/RfC	No RfD/RfC	No RfD/RfC	No RfD/RfC	1E-06	1.3	3.3	2.9	0.25
Benzo(a)anthracene	0.1	1,293	1,304	4,243	5,340	177	1,171	1E-06	1.7	7.3	4.7	0.49
Benzo(a)pyrene	0.1	1,293	1,304	4,243	5,340	177	1,171	1E-06	0.17	0.73	0.47	0.05
Benzo(b)fluoranthene	0.1	1,293	1,304	4,243	5,340	177	1,171	1E-06	1.7	7.3	4.7	0.49
Benzo(g,h,i)perylene	0.1	1,293	1,304	4,243	5,340	177	1,171	1E-06	1.7	7.3	4.7	0.5
Benzo(k)fluoranthene	0.1	1,293	1,304	4,243	5,340	177	1,171	1E-06	17	73	47	4.9
Chrysene	0.1	1,293	1,304	4,243	5,340	177	1,171	1E-06	165	734	466	49
Dibenzo(a,h)anthracene	0.1	1,293	1,304	4,243	5,340	177	1,171	1E-06	0.17	0.73	0.47	0.05
Indeno(1,2,3-cd)pyrene	0.1	1,293	1,304	4,243	5,340	177	1,171	1E-06	1.7	7.3	4.7	0.49
N-Nitrosodiphenylamine	0.1	No RfD/RfC	No RfD/RfC	No RfD/RfC	No RfD/RfC	No RfD/RfC	No RfD/RfC	1E-06	207	1,025	605	66

Subchronic RfDs are used for the contruction worker. In lieu of a subchronic RfD, the chronic RfD is substituted.

*The human health RGO for cancer effects for dinitrotoluene is calculated using a cancer slope factor for a mixture of 2,4- and 2,6-dinitrotoluene. An EPA-approved slope factor is not available for either compound individually.

**For lead in soil, the residential RGO is the soil screening level (EPA 1994a). RGOs for the workers will be presented in the Feasibility Study.

Table 6-99. Remedial Goal Options: Soil (Ingestion, Dermal Contact, and Inhalation of Dust) (Continued)
Alabama Army Ammunition Plant, Childersburg, Alabama

Chemical	Noncarcinogenic Effects							Carcinogenic Effects				
	Target Hazard Index	Industrial Worker	Construction Worker	Recreational		Residential		Target Cancer Risk	Industrial Worker	Construction Worker	Recreational	Residential
				Child	Adult	Child	Adult				Integrated Child/Adult	Integrated Child/Adult
INORGANICS (µg/g)												
Antimony	1	120	53	431	524	21	101	1E-05	No CSF	No CSF	No CSF	No CSF
Arsenic	1	478	62	896	1,343	23	1,548	1E-05	27	48	52	3.9
Hexavalent Chromium	1	773	366	2,883	3,689	137	632	1E-05	129	1,346	773	51
Iron	1	345,789	59,113	773,953	1,105,529	21,991	566,379	1E-05	No CSF	No CSF	No CSF	No CSF
Lead	1	No RfD/RfC**	No RfD/RfC**	No RfD/RfC	No RfD/RfC	400**	400**	1E-05	No CSF**	No CSF**	No CSF	400**
Manganese	1	2,225	1,431	9,952	18,774	403	1,665	1E-05	No CSF	No CSF	No CSF	No CSF
Nickel	1	28,595	4,076	57,039	84,128	1,508	67,966	1E-05	No CSF	No CSF	No CSF	No CSF
ORGANICS (µg/g)												
2,4,6-Trinitrotoluene	1	348	89	976	1,299	33	378	1E-05	650	2,068	1,625	151
2,4-Dinitrotoluene	1	1,729	373	4,432	6,075	140	2,140	1E-05	36	96	83	7.3
Aroclor-1248	1	No RfD/RfC	No RfD/RfC	No RfD/RfC	No RfD/RfC	No RfD/RfC	No RfD/RfC	1E-05	13	33	29	2.5
Aroclor-1254	1	18	8.0	45	62	1.4	23	1E-05	13	33	29	2.5
Aroclor-1260	1	No RfD/RfC	No RfD/RfC	No RfD/RfC	No RfD/RfC	No RfD/RfC	No RfD/RfC	1E-05	13	33	29	2.5
Benzo(a)anthracene	1	12,931	13,041	42,431	53,397	1,772	11,705	1E-05	17	73	47	4.9
Benzo(a)pyrene	1	12,931	13,041	42,431	53,397	1,772	11,705	1E-05	1.7	7.3	4.7	0.49
Benzo(b)fluoranthene	1	12,931	13,041	42,431	53,397	1,772	11,705	1E-05	17	73	47	4.9
Benzo(g,h,i)perylene	1	12,931	13,041	42,431	53,397	1,772	11,705	1E-05	17	73	47	4.9
Benzo(k)fluoranthene	1	12,931	13,041	42,431	53,397	1,772	11,705	1E-05	165	734	466	49
Chrysene	1	12,931	13,041	42,431	53,397	1,772	11,705	1E-05	1,652	7,342	4,663	489
Dibenzo(a,h)anthracene	1	12,931	13,041	42,431	53,397	1,772	11,705	1E-05	1.7	7.3	4.7	0.49
Indeno(1,2,3-cd)pyrene	1	12,931	13,041	42,431	53,397	1,772	11,705	1E-05	17	73	47	4.9
N-Nitrosodiphenylamine	1	No RfD/RfC	No RfD/RfC	No RfD/RfC	No RfD/RfC	No RfD/RfC	No RfD/RfC	1E-05	2,071	10,253	6,046	659

Subchronic RfDs are used for the contruction worker. In lieu of a subchronic RfD, the chronic RfD is substituted.

*The human health RGO for cancer effects for dinitrotoluene is calculated using a cancer slope factor for a mixture of 2,4- and 2,6-dinitrotoluene. An EPA-approved slope factor is not available for either compound individually.

**For lead in soil, the residential RGO is the soil screening level (EPA 1994a). RGOs for the workers will be presented in the Feasibility Study.

Table 6-99. Remedial Goal Options: Soil (Ingestion, Dermal Contact, and Inhalation of Dust) (Continued)
Alabama Army Ammunition Plant, Childersburg, Alabama

	Noncarcinogenic Effects							Carcinogenic Effects				
				Recreational		Residential					Recreational	Residential
Chemical	Target Hazard Index	Industrial Worker	Construction Worker	Child	Adult	Child	Adult	Target Cancer Risk	Industrial Worker	Construction Worker	Integrated Child/Adult	Integrated Child/Adult
INORGANICS (µg/g)												
Antimony	3	361	159	1,292	1,572	62	302	1E-04	No CSF	No CSF	No CSF	No CSF
Arsenic	3	1,434	186	2,688	4,029	69	4,644	1E-04	274	476	523	39
Hexavalent Chromium	3	2,319	1,098	8,648	11,068	410	1,895	1E-04	1,293	13,464	7.726	513
Iron	3	1,037,368	177,339	2,321,859	3,316,587	65,972.7	1,699,138	1E-04	No CSF	No CSF	No CSF	No CSF
Lead	3	No RfD/RfC**	No RfD/RfC**	No RfD/RfC	No RfD/RfC	400**	400**	1E-04	No CSF**	No CSF**	No CSF	400**
Manganese	3	6,676	4,294	29,857	56,322	1,210	4,995	1E-04	No CSF	No CSF	No CSF	No CSF
Nickel	3	85,784	12,228	171,116	252,384	4,524	203,897	1E-04	No CSF	No CSF	No CSF	No CSF
ORGANICS (µg/g)												
2,4,6-Trinitrotoluene	3	1,045	266	2,927	3,897	100	1,133	1E-04	6,504	20,676	16,248	1,513
2,4-Dinitrotoluene	3	5,186	1,118	13,296	18,224	420	6,419	1E-04	356	959	829	73
Aroclor-1248	3	No RfD/RfC	No RfD/RfC	No RfD/RfC	No RfD/RfC	No RfD/RfC	No RfD/RfC	1E-04	125	329	288	25
Aroclor-1254	3	54	24	135	186	4.2	68	1E-04	125	329	288	25
Aroclor-1260	3	No RfD/RfC	No RfD/RfC	No RfD/RfC	No RfD/RfC	No RfD/RfC	No RfD/RfC	1E-04	125	329	288	25
Benzo(a)anthracene	3	38,794	39,124	127,294	160,190	5,316	35,116	1E-04	165	734	466	49
Benzo(a)pyrene	3	38,794	39,124	127,294	160,190	5,316	35,116	1E-04	17	73	47	4.9
Benzo(b)fluoranthene	3	38,794	39,124	127,294	160,190	5,316	35,116	1E-04	165	734	466	49
Benzo(g,h,i)perylene	3	38,794	39,124	127,294	160,190	5,316	35,116	1E-04	165	734	466	49
Benzo(k)fluoranthene	3	38,794	39,124	127,294	160,190	5,316	35,116	1E-04	1,652	7,342	4,663	489
Chrysene	3	38,794	39,124	127,294	160,190	5,316	35,116	1E-04	16,517	73,422	46,631	4,890
Dibenzo(a,h)anthracene	3	38,794	39,124	127,294	160,190	5,316	35,116	1E-04	17	73	47	4.9
Indeno(1,2,3-cd)pyrene	3	38,794	39,124	127,294	160,190	5,316	35,116	1E-04	165	734	466	49
N-Nitrosodiphenylamine	3	No RfD/RfC	No RfD/RfC	No RfD/RfC	No RfD/RfC	No RfD/RfC	No RfD/RfC	1E-04	20,709	102,528	60,457	6,592

Subchronic RfDs are used for the contruction worker. In lieu of a subchronic RfD, the chronic RfD is substituted.

*The human health RGO for cancer effects for dinitrotoluene is calculated using a cancer slope factor for a mixture of 2,4- and 2,6-dinitrotoluene. An EPA-approved slope factor is not available for either compound individually.

**For lead in soil, the residential RGO is the soil screening level (EPA 1994a). RGOs for the workers will be presented in the Feasibility Study.

Table 6-100. Remedial Goal Options: Groundwater
Alabama Army Ammunition Plant, Childersburg, Alabama

Ingestion Exposure					
		Noncarcinogenic Effects			Carcinogenic Effects
	Target	Future Land Use Scenarios		Target	Future Land Use Scenarios
	Hazard	Residential		Cancer	Residential
Chemical	Index	Child	Adult	Risk	Integrated Child/Adult
INORGANICS (µg/L)					
Antimony	0.1	0.63	1.5	1E-06	No CSF
Arsenic	0.1	0.47	1.1	1E-06	0.04
Iron	0.1	469	1,095	1E-06	No CSF
Lead	0.1	15*	15*	1E-06	15*
Manganese	0.1	38	88	1E-06	No CSF
Thallium	0.1	0.13	0.29	1E-06	No CSF
ORGANICS (µg/L)					
2-Amino-4,6-Dinitrotoluene	0.1	3.1	7.3	1E-06	0.10
4-Amino-2,6-Dinitrotoluene	0.1	1.6	3.7	1E-06	0.10
Benzo(a)pyrene	0.1	47	110	1E-06	0.01
Benzo(b)fluoranthene	0.1	47	110	1E-06	0.09
bis(2-Ethylhexyl)phthalate	0.1	31	73	1E-06	4.8
2,4-Dinitrotoluene	0.1	3.1	7.3	1E-06	0.10
2,6-Dinitrotoluene	0.1	1.6	3.7	1E-06	0.10
Nitrobenzene	0.1	0.78	1.8	1E-06	No CSF
Pentachlorophenol	0.1	47	110	1E-06	0.56
RDX	0.1	4.7	11	1E-06	0.61
2,4,6-Trinitrotoluene	0.1	0.78	1.8	1E-06	2.2
Vinyl chloride	0.1	2.0	4.7	1E-06	0.04
INORGANICS (µg/L)					
Antimony	1	6.3	15	1E-05	No CSF
Arsenic	1	4.7	11	1E-05	0.45
Iron	1	4,693	10,950	1E-05	No CSF
Lead	1	15*	15*	1E-05	15*
Manganese	1	375	876	1E-05	No CSF
Thallium	1	1.3	2.9	1E-05	No CSF
ORGANICS (µg/L)					
2-Amino-4,6-Dinitrotoluene	1	31	73	1E-05	0.99
4-Amino-2,6-Dinitrotoluene	1	16	37	1E-05	0.99
Benzo(a)pyrene	1	469	1,095	1E-05	0.09
Benzo(b)fluoranthene	1	469	1,095	1E-05	0.92
bis(2-Ethylhexyl)phthalate	1	313	730	1E-05	48
2,4-Dinitrotoluene	1	31	73	1E-05	0.99
2,6-Dinitrotoluene	1	16	37	1E-05	0.99
Nitrobenzene	1	7.8	18	1E-05	No CSF
Pentachlorophenol	1	469	1,095	1E-05	5.6
RDX	1	47	110	1E-05	6.1
2,4,6-Trinitrotoluene	1	7.8	18	1E-05	22
Vinyl chloride	1	20	47	1E-05	0.35
INORGANICS (µg/L)					
Antimony	3	19	44	1E-04	No CSF
Arsenic	3	14	33	1E-04	4.5
Iron	3	14,079	32,850	1E-04	No CSF
Lead	3	15*	15*	1E-04	15*
Manganese	3	1,126	2,628	1E-04	No CSF
Thallium	3	4	9	1E-04	No CSF
ORGANICS (µg/L)					
2-Amino-4,6-Dinitrotoluene	3	94	219	1E-04	9.9
4-Amino-2,6-Dinitrotoluene	3	47	110	1E-04	9.9
Benzo(a)pyrene	3	1,408	3,285	1E-04	0.92
Benzo(b)fluoranthene	3	1,408	3,285	1E-04	9.2
bis(2-Ethylhexyl)phthalate	3	939	2,190	1E-04	480
2,4-Dinitrotoluene	3	94	219	1E-04	9.9
2,6-Dinitrotoluene	3	47	110	1E-04	9.9
Nitrobenzene	3	23	55	1E-04	No CSF
Pentachlorophenol	3	1,408	3,285	1E-04	56
RDX	3	141	329	1E-04	61
2,4,6-Trinitrotoluene	3	23	55	1E-04	224
Vinyl chloride	3	61	142	1E-04	3.5

Toxicity values are not available in IRIS or HEAST for 2-Amino-4,6-dinitrotoluene or 4-Amino-2,6-dinitrotoluene. The toxicity values for 2,4-Dinitrotoluene and 2,6-Dinitrotoluene, respectively, have been used as surrogates. In addition, the human health RGO for cancer effects is calculated using a cancer slope factor for a mixture of 2,4- and 2,6-Dinitrotoluene. An EPA-approved slope factors is not available for either compound individually.

*The RGO for lead in groundwater is the EPA action level in drinking water (EPA 1995c).

7. SCREENING AND BASELINE ECOLOGICAL RISK ASSESSMENT

Ecological risk assessment (ERA) defines the likelihood of harmful effects on plants and animals and their habitats as a result of exposure from chemicals. A screening ERA (SERA) for the study areas at the Alabama Army Ammunition Plant (ALAAP) was conducted by Science Applications International Corporation (SAIC) to evaluate the risk to plants, animals, and the environment from current and future exposure to contamination at the ALAAP study areas. A baseline ERA (BERA) was conducted on the screened ERA study areas. In addition, bioassays were conducted concurrently.

The initial regulatory guidance for the ERA is contained in the U.S. Environmental Protection Agency's (EPA) *Risk Assessment Guidance for Superfund (RAGS), Volume II, Environmental Evaluation Manual* (EPA 1989g) and subsequent documents (EPA 1991, 1992b). Further discussion on the scientific basis for assessing ecological effects and risk is presented in *Ecological Assessments of Hazardous Waste Sites: A Field and Laboratory Reference Document* (EPA 1989b). Other early 1990s guidance is provided in the *Framework for Ecological Risk Assessment* (EPA 1992a). A second generation of guidance consists of the *Procedural Guidance for Ecological Risk Assessments at U.S. Army Sites* (Wentsel et al. 1994), and its replacement, the *Tri-Service Procedural Guidelines for Ecological Risk Assessments* (Wentsel et al. 1996). The newly published *Ecological Risk Assessment Guidance* (EPA 1997) supercedes *RAGS, Volume II* (EPA 1989g). This latter guidance makes the distinction between the interrelated roles of screening and BERAs. Briefly, SERAs use conservative assumptions for exposures and effects, while BERAs use more realistic (and generally less conservative) exposures and effects. Last, *Guidelines for Ecological Assessment* (EPA 1998) supercedes the *Framework for Ecological Risk Assessment* (EPA 1992a).

These documents do not provide a detailed step-by-step approach to ERAs. Instead, they discuss an overall approach to considering ecological effects and identifying sources of information necessary to perform ERAs. Thus, professional knowledge and experience are essential to compensate for this lack of specific guidance and established methods. A team of risk scientists provides this professional experience.

7.1 SCOPE AND OBJECTIVES

The scope of the ERA is to characterize potential risk to plant and animal populations at the ALAAP study areas. The ERA assesses the risk to ecological receptors, including both terrestrial and aquatic species. Unlike the human health risk assessment, which focuses on individuals, the ERA focuses primarily on populations or groups of interbreeding individuals. The ERA process always addresses individuals if they are protected under the Endangered Species Act (ESA).

The objective of the ERA is to assess the potential for harmful effects on ecological receptors due to exposure to chemicals. Chemicals present at concentrations above background are

called chemicals exceeding background (CEBs). When it has been demonstrated in the SERA that CEBs may cause risk, they are called chemicals of potential ecological concern (COPECs). COPECs are further analyzed in a BERA. Those COPECs remaining at the end of the BERA are called chemicals of concern (COCs). At each exposure unit, the ERA examines both the direct and indirect effects of COPECs and COCs on ecological receptors.

Analytical results from various environmental media are compiled first in Appendix K and later in Appendix O to yield quantitative estimates of exposure to ecological receptors. Estimates of exposure to ecological receptors were used to assess hazard or risk potential of a CEB at the ALAAP study areas. This was done for the most important pathways and included soil, sediment, and surface water. Benchmark concentrations (concentrations below which there are no unacceptable adverse effects) of CEBs obtained from published literature serve as toxicity thresholds. In addition, food chain effects and toxicity reference values for terrestrial food chains are important aspects of the scope. The ratio of the exposure concentration (or dose) to the toxicity threshold concentration or the toxicity reference value results in a risk quotient. A risk quotient is calculated for each CEB and each receptor. Each risk quotient is compared to the number in the decision rule associated with each assessment endpoint (defined in Section 7.3.5). This number represents a pre-established goal for an ecological resource. It is expressed as a ratio to determine whether or not the risk quotient exceeds the decision rule or the assessment endpoint. If the risk quotient exceeds the decision rule, a feasibility study (FS) and even exposure unit remediation may be required to protect the ecological receptors. Uncertainties in the measured, estimated, and calculated concentrations on the final characterization of risk at ALAAP study areas are discussed qualitatively (Section 7.8).

7.2 PROCEDURAL FRAMEWORK

According to the *Framework for Ecological Risk Assessment* (EPA 1992a), the ERA process consists of three interrelated phases: problem formulation, analysis (composed of exposure assessment and ecological effects assessment), and risk characterization. In conducting the ERA for the study areas at ALAAP, these three phases were completed by performing the following four interrelated steps:

Problem Formulation (Step 1)—Problem formulation establishes the goals, breadth, and focus of the ERA and provides a preliminary characterization of chemical stressors (chemicals that restrict growth and reproduction or otherwise disturb the balance of ecological populations and systems) present in the various habitats at the ALAAP study areas. The problem formulation step also includes a preliminary characterization of the components, especially the receptor species, in the ecosystem likely to be at risk. In addition, problem formulation also includes the selection of assessment and measurement endpoints as a basis for developing a conceptual model of stressors, components, and effects. The procedures for determining COPECs are selected in this step (Section 7.3).

Exposure Assessment (Step 2)—Exposure assessment evaluates the exposures of ecological receptors to chemical and physical stressors. It also describes the ecological receptors and defines the route, magnitude, frequency, duration, trend, and spatial pattern of the exposure of each receptor population or habitat to a chemical or physical stressor (Section 7.4).

Effects Assessment (Step 3)—Effects assessment evaluates the ecological response to COPECs and physical stressors in terms of the selected assessment and measurement endpoints. The effects assessment results in a profile of the ecological response of animals to the chemical concentrations or doses of COPECs and to other types of stress to which receptors are exposed. Data from both field observations and controlled laboratory studies are used to assess ecological effects (Section 7.5).

Risk Characterization (Step 4)—Risk characterization integrates exposure of COPECs on receptor populations using risk quotients (ratios of exposure to effect). The resulting data are used to define the risk from chemicals at each exposure unit, in contrast to background (naturally occurring) risk, and to make information available about the potential for population and ecosystem recovery (Section 7.6).

The discussion of the ERA presented in this report is organized in accordance with the four steps of the EPA framework. Sections 7.3 through 7.6 detail the technical issues and data evaluation procedures associated with each step in the SERA. Section 7.7 provides the procedures and findings of the BERA for study areas from the SERA. Section 7.8 evaluates the degree of reliability or uncertainty of these methodological steps and the data used. The major findings for soil, sediment, and surface water risks are summarized in Section 7.9.

Both screening and BERAs are performed in the ALAAP work. As stated earlier, screening means the use of conservative exposure and effects while baseline means the use of less conservative exposure and effects. Only those study areas not eliminated in the SERA are evaluated in the BERA. There is one set of exposure/effect assumptions for the SERA while there is another set of exposure/effect assumptions for the BERA. Each is explained, in turn, in this report.

7.3 PROBLEM FORMULATION, INCLUDING DATA COLLECTION AND EVALUATION

The first step of EPA's approach to the ERA process, i.e., problem formulation, includes the following:

- Determination of the scope of the assessment (discussed earlier in Section 7.1)
- Identification of the COPECs (Section 7.3.1)
- Identification of applicable or relevant and appropriate requirements (ARARs) Section 7.3.2)

- A conceptual model of the site (Section 7.3.3)
- Characterization of receptor species and their habitats (Section 7.3.4)
- Selection of assessment and measurement endpoints for the ERA (Section 7.3.5).

Section 7.7 contains a method summary of problem formulation for the BERA.

7.3.1 Identification of Chemicals of Potential Ecological Concern

COPECs are those substances detected at ALAAP that are above background concentrations and have a risk potential to plants and animals. The potential abiotic exposure media for the ALAAP Remedial Investigation (RI) are air, soil (surface and subsurface), surface water, sediment, and groundwater. Biota may be considered another exposure medium. The screening of chemicals above background concentrations was conducted for surface soil (0 to <1 feet) for exposure to ecological receptors in those horizons, surface water, and sediment because these are the three principal media of exposure to plants and animals. The steps preceding the selection of CEBs and COPECs are shown in **Figure 7-1**. Figure 7-1 also shows the steps needed to define a COC.

7.3.2 Identification of ARARs

This section presents ARARs for surface water at ALAAP (**Table 7-1**). There are no known ARARs for soil and sediment. Chemical-specific ARARs set concentration or discharge limits in various environmental media for specific hazardous substances, pollutants, or contaminants (52 *FR* 32496). Chemical-specific ARARs for this ERA consist of water quality standards promulgated by the Alabama Department of Environmental Management (ADEM) (Alabama Administrative Code, Chapter 335-6-10, "Water Quality Criteria"). The water quality criteria are based on designated use classifications of specific water bodies, as described in Alabama Administrative Code, Chapter 335-6-11. The "Fish and Wildlife" classification, which states that waters must be suitable for fish, aquatic life, and wildlife propagation, determine the ARARs for COPECs in ALAAP surface water. The ambient water quality criteria (AWQC) for COPECs in ALAAP surface water based on the Fish and Wildlife designated use are summarized in Table 7-1. For chemicals that had insufficient toxicological data to allow calculation of water quality criteria by ADEM, EPA Tier II acute and chronic values (EPA 1993e) also are presented. Tier II values are expected to be higher than AWQC in no more than 20 percent of cases (Suter and Mabrey 1994). Calculation of the Tier II values requires less data and less stringent data quality characteristics than AWQCs; consequently, Tier II values are not ARARs.

Surface water concentrations of COPECs exceeded ADEM water quality criteria for the Fish and Wildlife designated use classification in the four ALAAP aquatic study areas where COPECs were detected (Table 7-1). In all four cases, a high percentage of the samples exceeded the ADEM criteria for copper and iron.

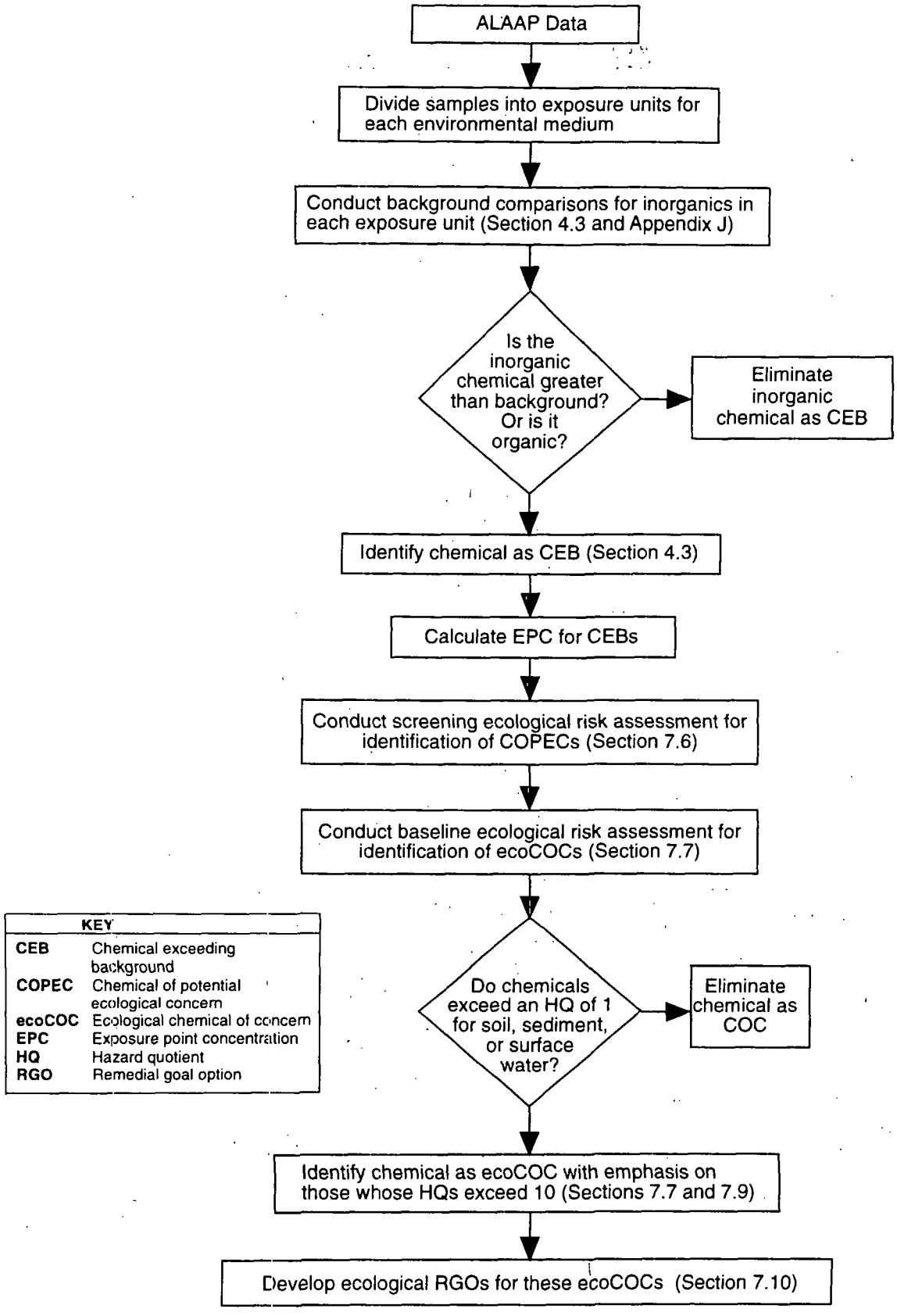


Figure 7-1. Flowchart for Ecological Risk Assessment

Table 7-1. ARARs Comparison with State and Federal Criteria for Surface Water
Alabama Army Ammunition Plant, Childersburg, Alabama

	Exceedances of ADEM Freshwater Chronic Criteria					
	Proportion	Sample ID			Sample	ADEM Criteria
Chemical	Which Exceed	Site ID	Site Type	Field Sample	Conc. (ug/L)	(ug/L)
Copper	1 of 1, Study Area 9	SW-09-028	POND	SAIC01	13.6	10.71
Iron	1 of 1, Study Area 9	SW-09-028	POND	SAIC01	1570	1000
Lead	1 of 1, Study Area 9	SW-09-028	POND	SAIC01	2.97	2.74
Iron	1 of 1, Study Area 16	SW-16-038	POND	SAIC01	10800	1000
Iron	4 of 5, Study Area 21	BW-21-002	STRM	SAIC01	2290	1000
		SW-21-004	STRM	SAIC02	2750	
		SW-21-014	STRM	SAIC01	3120	
		SW-12-004	STRM	SAIC01	7460	
Lead	1 of 2, Study Area 21	BW-21-002	STRM	SAIC01	6.18	2.74
Iron	10 of 10, Study Area 26	SW-27-007	POND	SAIC01	1030	1000
		BW-26-002	STRM	SAIC01	1400	
		SW-26-005	POND	SAIC01	1750	
		SW-26-006	POND	SAIC01	1800	
		SW-26-003	POND	SAIC01	2300	
		SW-27-036	POND	SAIC01	3410	
		SW-27-008	POND	SAIC01	4900	
		SW-27-036	POND	SAIC02	5310	
		SW-27-037	POND	SAIC01	5470	
		SW-27-035	POND	SAIC01	8370	
Iron	5 of 5, Study Area 27	SW-27-020	POND	SAIC01	1150	1000
		SW-27-011	POND	SAIC01	1150	
		SW-27-016	POND	SAIC01	1480	
		SW-SP-012	SPRG	SAIC02	6320	
		SW-SP-013	SPRG	SAIC01	8420	
Lead	1 of 1, Study Area 27	SW-SP-012	SPRG	SAIC01	16.5	2.74
	Exceedances of National Ambient Water Quality Criteria (NAWQC)					
	Proportion	Sample ID			Sample	NAWQC Criteria
Chemical	Which Exceed	Site ID	Site Type	Field Sample	Conc. (ug/L)	(ug/L)
Copper	1 of 1, Study Area 9	SW-09-028	POND	SAIC01	13.6	12
Iron	1 of 1, Study Area 9	SW-09-028	POND	SAIC01	1570	1000
Lead	1 of 1, Study Area 9	SW-09-028	POND	SAIC01	2.97	2.5
Iron	1 of 1, Study Area 16	SW-16-038	POND	SAIC01	10800	1000
Aluminum	3 of 4, Study Area 21	SW-21-001	STRM	SAIC01	544	87
		SW-21-014	STRM	SAIC01	638	87
		SW-21-004	STRM	SAIC01	1720	87
		BW-21-002	STRM	SAIC01	2210	87
Iron	4 of 5, Study Area 21	BW-21-002	STRM	SAIC01	2290	1000
		SW-21-004	STRM	SAIC02	2750	1000
		SW-21-014	STRM	SAIC01	3120	1000
		SW-21-004	STRM	SAIC01	7460	1000
Lead	1 of 2, Study Area 21	SW-21-014	STRM	SAIC01	6.18	3
	Exceedances of EPA TIERII Acute Criteria					
	Proportion	Sample ID			Sample	TIERII Criteria
Chemical	Which Exceed	Site ID	Site Type	Field Sample	Conc. (ug/L)	(ug/L)
Barium	1 of 5, Study Area 21	SW-21-004	STRM	SAIC01	83.3	69.1
Manganese	2 of 5, Study Area 21	BW-21-002	STRM	SAIC01	1700	1470
		SW-21-004	STRM	SAIC02	1800	
Barium	3 of 10, Study Area 26	SW-27-035	POND	SAIC01	73.6	69.1
		SW-27-036	POND	SAIC01	80.5	
		SW-27-036	POND	SAIC02	132	
Manganese	3 of 10, Study Area 26	SW-27-036	POND	SAIC01	1520	1470
		SW-27-035	POND	SAIC01	1770	
		SW-27-036	POND	SAIC02	7240	
Barium	3 of 10, Study Area 27	SW-27-020	POND	SAIC01	75.6	69.1
		SW-SP-012	SPRG	SAIC02	78	
		SW-SP-012	SPRG	SAIC01	79.7	
Manganese	3 of 10, Study Area 27	SW-27-011	POND	SAIC01	1590	1470
		SW-SP-012	SPRG	SAIC01	4430	
		SW-SP-012	SPRG	SAIC02	6300	

Table 7-1. ARARs Comparison with State and Federal Criteria for Surface Water (Continued)
Alabama Army Ammunition Plant, Childersburg, Alabama

	Exceedances of EPA TIERII Chronic Criteria					
	Proportion	Sample ID			Sample	TIERII Criteria
Chemical	Which Exceed	Site ID	Site Type	Field Sample	Conc. (ug/L)	(ug/L)
Barium	1 of 1, Study Area 9	SW-09-028	POND	SAIC01	27.3	3.8
Manganese	1 of 1, Study Area 9	SW-09-028	POND	SAIC01	99.6	80.3
Barium	1 of 1, Study Area 16	SW-16-038	POND	SAIC01	14.2	3.8
Manganese	1 of 1, Study Area 16	SW-16-038	POND	SAIC02	1200	80.3
Barium	5 of 5, Study Area 21	BW-21-002	STRM	SAIC01	39	3.8
		BW-21-024	STRM	SAIC02	41	
		SW-21-001	STRM	SAIC01	49.8	
		SW-21-014	STRM	SAIC01	83.3	
		SW-21-004	STRM	SAIC01	65.3	
Manganese	5 of 5, Study Area 21	BW-21-001	STRM	SAIC01	121	80.3
		BW-21-004	STRM	SAIC02	1250	
		SW-21-014	STRM	SAIC01	1350	
		SW-21-002	STRM	SAIC01	1700	
		SW-21-004	STRM	SAIC01	1800	
Barium	10 of 10, Study Area 26	SW-27-007	POND	SAIC01	15	3.8
		BW-26-002	STRM	SAIC01	34.4	
		SW-26-003	POND	SAIC01	39.9	
		SW-27-008	POND	SAIC01	46.6	
		SW-27-037	POND	SAIC01	50.8	
		SW-26-005	POND	SAIC01	51.5	
		SW-26-006	POND	SAIC01	53.6	
		SW-27-035	POND	SAIC01	73.6	
		SW-27-036	POND	SAIC01	80.5	
		SW-27-036	POND	SAIC02	132	
Manganese	10 of 10, Study Area 26	SW-27-007	POND	SAIC01	192	80.3
		SW-26-005	POND	SAIC01	301	
		SW-26-003	POND	SAIC01	433	
		SW-26-006	POND	SAIC01	459	
		BW-26-002	STRM	SAIC01	573	
		SW-27-037	POND	SAIC01	1050	
		SW-27-008	POND	SAIC01	1190	
		SW-27-036	POND	SAIC01	1520	
		SW-27-035	POND	SAIC01	1770	
		SW-27-036	POND	SAIC02	7240	
Barium	9 of 9, Study Area 27	SW-27-013	POND	SAIC01	19.7	3.8
		SW-27-010	POND	SAIC01	21.2	
		SW-27-015	POND	SAIC01	30.8	
		SW-27-021	POND	SAIC01	35.6	
		SW-27-016	POND	SAIC01	45.6	
		SW-27-011	POND	SAIC01	58.2	
		SW-27-020	POND	SAIC01	75.6	
		SW-SP-012	SPRG	SAIC02	78	
		SW-SP-012	SPRG	SAIC01	79.7	
Manganese	9 of 9, Study Area 27	SW-27-021	POND	SAIC01	138	80.3
		SW-27-010	POND	SAIC01	302	
		SW-27-015	POND	SAIC01	309	
		SW-27-013	POND	SAIC01	549	
		SW-27-016	POND	SAIC01	902	
		SW-27-020	POND	SAIC01	1310	
		SW-27-011	POND	SAIC01	1590	
		SW-SP-012	SPRG	SAIC01	4430	
		SW-SP-012	SPRG	SAIC02	6300	

Barium and manganese concentrations in 20 to 25 percent of the samples at the Red Water Ditch (Study Area 21) and Beaver Pond Drainage System (Study Area 27) exceed the EPA Tier II acute values. Concentrations of these COPECs exceeded Tier II-chronic values at all four study areas where they were detected.

7.3.3 Conceptual Site Model

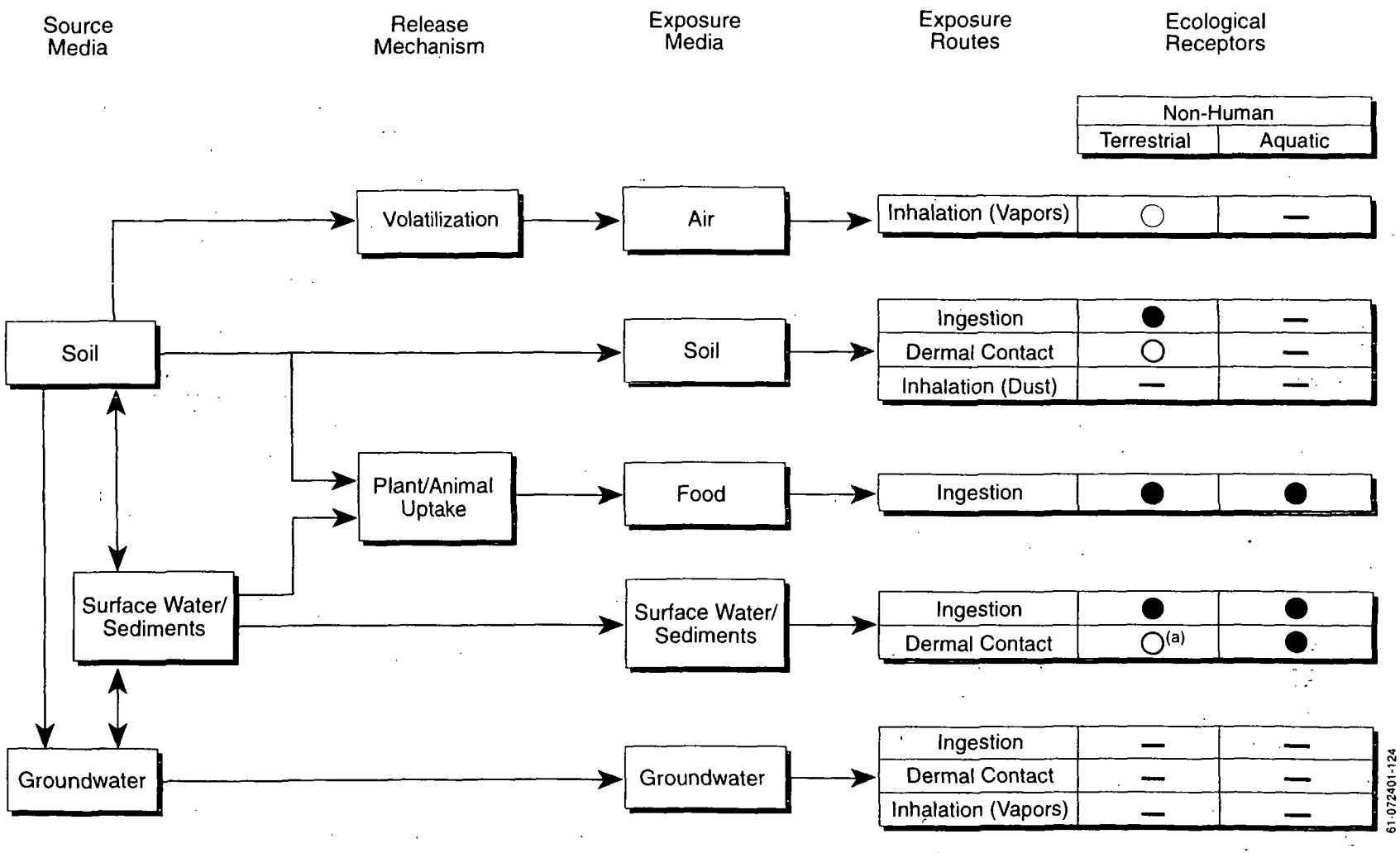
As shown in the conceptual site model, ecological receptors at ALAAP are exposed to potentially hazardous chemicals in soil, surface water, sediment, or food over several pathways (**Figure 7-2**). The figure shows the exposure pathways for terrestrial and aquatic receptors. For the different types of receptors, pathways that are evaluated quantitatively in the exposure assessment for the ERA are indicated by closed circles. Open circles indicate pathways that may exist, but are considered insignificant. Some pathways do not exist at ALAAP (e.g., aquatic receptors are not exposed to contaminants in air) and are not evaluated further. The most important pathways by which ecological receptors at ALAAP are potentially exposed to site contaminants were quantitatively evaluated in the ERA.

7.3.4 Characterization of Receptor Species and Their Habitats

The methods for ecological characterization of ALAAP, including field reconnaissance, habitat mapping, and collection of biological samples, are described in Section 3.7. The field reconnaissance conducted by SAIC and the habitat mapping based on aerial photography describe the habitats of the species. These habitats include wetlands, ponds/impoundments, pines, mixed upland hardwoods, bottomland hardwood, old field (early sere), old field, industrial areas, and other. The habitat map and approximate acreages are provided in Section 7.4 and descriptions of these habitats are contained in Section 2.7. Biological samples were collected for contaminant body burden analysis of cottontail rabbits, fish, and crayfish. These data were used to illustrate whether COPECs move from the abiotic environment to organisms in food webs and to document chemical relationships of media to organisms. These food webs are provided in Section 7.4. The body burden data are presented in Section 4 and used in Section 7.4.

7.3.5 Ecological Assessment and Measurement Endpoints

Protecting ecological resources, such as the habitats and species of plants and animals discussed in Section 2.7, is the principal motivation for conducting ecological risk assessments. Key aspects of ecological protection are presented as policy goals (i.e., general goals established by legislation or agency policy) based on societal concern for protection of certain environmental resources. For example, environmental protection is mandated by a variety of legislation and Government agency policies (e.g., Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA] and the National Environmental Policy Act [NEPA]). Other legislation includes the ESA 16 U.S.C. §§ 1531-1544 (1993, as amended) and the Migratory Bird Treaty Act, 16 U.S.C. §§ 703-711 (1993, as amended). Four policy goals were defined for the ALAAP ERA, as shown in **Table 7-2**. To determine whether these protection goals are met at ALAAP, 12



● Complete pathway evaluated quantitatively
○ Complete pathway evaluated qualitatively
— Incomplete pathway, not evaluated
(a) Surface water only

Figure 7-2. Exposure Pathways for Terrestrial and Aquatic Receptors

Table 7-2. Policy Goals, Ecological Assessment Endpoints, Measurement Endpoints, and Decision Rules Alabama Army Ammunition Plant, Childersburg, Alabama

Policy Goals	Assessment Endpoint	Measurement Endpoint	Decision Rule
Policy Goal 1: The preservation and conservation of T&E species and their critical habitats.	**Assessment Endpoint 1:** Preservation of any State or federally designated threatened or endangered species. **Endpoint Species:** none known.	**Measurement Endpoint 1:** Observational data on presence of T&E species. Modeled contaminant concentrations in prey (shrews, woodcocks, and rabbits) based on measured soil concentrations.	**Decision Rule for Assessment Endpoint 1:** If T&E species are not present, or RME concentrations in the media do not contribute to chronic NOAEL (SERA) or chronic LOAEL (BERA) exceedance (i.e., HQs <1), then it is indicated that the contaminant alone is unlikely to cause adverse ecological effects, and, therefore, the T&E species are preserved. If the HQ >1, a weight-of-evidence evaluation will be conducted to determine the potential for ecological risk and the need for any additional measurements or calculations.
	Assessment Endpoint 2: Maintenance of plant community for erosion control and energy production. **Endpoint Species:** plants of various species.	**Measurement Endpoint 2:** Measured soil contaminant concentrations.	**Decision Rule for Assessment Endpoint 2:** If the HQ is <1, then it is indicated that the contaminant alone is unlikely to cause adverse ecological effects and, therefore, maintain the plant populations and communities. If the HQ >1, a weight-of-evidence evaluation will be conducted to determine the potential for ecological risk and the need for any additional measurements or calculations.
Policy Goal 2: The maintenance and protection of terrestrial populations and ecosystems.	**Assessment Endpoint 3:** Maintenance of soil-dwelling invertebrate community for nutrient and energy processing. **Endpoint Species:** earthworms.	**Measurement Endpoint 3:** Measured soil contaminant concentrations.	**Decision Rule for Assessment Endpoint 3:** If the HQ is <1, then it is indicated that the contaminant alone is unlikely to cause adverse ecological effects and, therefore, the soil invertebrate community is maintained. If the HQ >1, a weight-of-evidence evaluation will be conducted to determine the potential for ecological risk and the need for any additional measurements or calculations.
	Assessment Endpoint 4: Maintenance of populations of herbivorous animals. **Endpoint Species:** cottontail rabbits and deer.	**Measurement Endpoint 4:** Modeled contaminant concentrations in food chain based on measured soil contaminant concentrations.	**Decision Rule for Assessment Endpoint 4:** If the HQ is <1, then it is indicated that the contaminant alone is unlikely to cause adverse ecological effects and, therefore, populations of the herbivores, e.g., cottontail rabbits, are maintained. If the HQ >1, a weight-of-evidence evaluation will be conducted to determine the potential for ecological risk and the need for any additional measurements or calculations.

HQ = Hazard (risk) quotient
LOAEL = Lowest-observable-adverse-effects level
NOAEL = No-observable-adverse-effects level
RME = Reasonable maximum exposure
T&E = Threatened and endangered

Table 7-2. Policy Goals, Ecological Assessment Endpoints, Measurement Endpoints, and Decision Rules Alabama Army Ammunition Plant, Childersburg, Alabama (Continued)

Policy Goals	Assessment Endpoint	Measurement Endpoint	Decision Rule
Policy Goal 2 (continued): The maintenance and protection of terrestrial populations and ecosystems.	**Assessment Endpoint 5:** Maintenance of worm-eating and/or insectivorous animals. **Endpoint Species:** mammal—shrew; bird—woodcock.	**Measurement Endpoint 5:** Modeled contaminant concentrations in earthworms and other prey based on measured soil contaminant concentrations.	**Decision Rule for Assessment Endpoint 5:** If the HQ is <1, then it is indicated that the contaminant alone is unlikely to cause adverse ecological effects and, therefore, populations of worm-eating and/or insectivorous animals are maintained. If the HQ >1, a weight-of-evidence evaluation will be conducted to determine the potential for ecological risk and the need for any additional measurements or calculations.
	Assessment Endpoint 6: Maintenance of terrestrial predators. **Endpoint Species:** mammal—red fox; bird—red-tailed hawk.	**Measurement Endpoint 6:** Modeled contaminant concentrations in prey (shrews, woodcocks, and rabbits) based on measured soil contaminant concentrations.	**Decision Rule for Assessment Endpoint 6:** If the HQ is <1, then it is indicated that the contaminant alone is unlikely to cause adverse ecological effects, and therefore, populations of terrestrial predators are maintained. If the HQ >1, a weight-of-evidence evaluation will be conducted to determine the potential for ecological risk and the need for any additional measurements or calculations.
Policy Goal 3: The maintenance and protection of aquatic populations and ecosystems.	**Assessment Endpoint 7:** Maintenance of aquatic vegetation. **Endpoint Species:** aquatic vegetation.	**Measurement Endpoint 7:** Measured surface water contaminant concentrations.	**Decision Rule for Assessment Endpoint 7:** If the HQ is <1, then it is indicated that the contaminant alone is unlikely to cause adverse ecological effects, and therefore, populations of aquatic vegetation are maintained. If the HQ >1, a weight-of-evidence evaluation will be conducted to determine the potential for ecological risk and the need for any additional measurements or calculations.
	Assessment Endpoint 8: Maintenance of sediment-dwelling organisms. **Endpoint Species:** sediment-dwelling organisms.	**Measurement Endpoint 8:** Measured sediment contaminant concentrations.	**Decision Rule for Assessment Endpoint 8:** If the HQ is <1, then it is indicated that the contaminant alone is unlikely to cause adverse ecological effects, and therefore, populations of sediment-dwelling organisms are maintained. If the HQ >1, a weight-of-evidence evaluation will be conducted to determine the potential for ecological risk and the need for any additional measurements or calculations.

HQ = Hazard (risk) quotient
LOAEL = Lowest-observable-adverse-effects level
NOAEL = No-observable-adverse-effects level
RME = Reasonable maximum exposure
T&E = Threatened and endangered

Table 7-2. Policy Goals, Ecological Assessment Endpoints, Measurement Endpoints, and Decision Rules Alabama Army Ammunition Plant, Childersburg, Alabama (Continued)

Policy Goals	Assessment Endpoint	Measurement Endpoint	Decision Rule
Policy Goal 3 (continued): The maintenance and protection of aquatic populations and ecosystems.	**Assessment Endpoint 9:** Maintenance of aquatic organisms. **Endpoint Species:** fish.	**Measurement Endpoint 9:** Measured surface water contaminant concentrations.	**Decision Rule for Assessment Endpoint 9:** If the HQ is <1, then it is indicated that the contaminant alone is unlikely to cause adverse ecological effects, and therefore, populations of aquatic organisms are maintained. If the HQ >1, a weight-of-evidence evaluation will be conducted to determine the potential for ecological risk and the need for any additional measurements or calculations.
	Assessment Endpoint 10: Maintenance of aquatic community. **Endpoint Species:** fish community.	**Measurement Endpoint 10:** Measured surface water contaminant concentrations.	**Decision Rule for Assessment Endpoint 10:** If the HQ is <1, then it is indicated that the contaminant alone is unlikely to cause adverse ecological effects, and therefore, populations of aquatic community are maintained. If the HQ >1, a weight-of-evidence evaluation will be conducted to determine the potential for ecological risk and the need for any additional measurements or calculations.
	Assessment Endpoint 11: Maintenance of terrestrial predators who eat aquatic prey. **Endpoint Species:** mammal—mink; bird—great blue heron.	**Measurement Endpoint 11:** Modeled contaminant concentrations in prey (fish, other) based on measured water and predicted prey contaminant concentrations.	**Decision Rule for Assessment Endpoint 11:** If the HQ is <1, then it is indicated that the contaminant alone is unlikely to cause adverse ecological effects, and therefore, populations of terrestrial predators of aquatic organisms are maintained. If the HQ >1, a weight-of-evidence evaluation will be conducted to determine the potential for ecological risk and the need for any additional measurements or calculations.
Policy Goal 4: The protection of wetlands.	**Assessment Endpoint 12:** No degradation of wetlands.	**Measurement Endpoint 12:** Measured soil concentrations.	**Decision Rule for Assessment Endpoint 12:** If the HQ is <1, then it is indicated that the contaminant alone is unlikely to cause adverse ecological effects, and therefore, wetlands are maintained. If the HQ >1, a weight-of-evidence evaluation will be conducted to determine the potential for ecological risk and the need for any additional measurements or calculations.

HQ = Hazard (risk) quotient
LOAEL = Lowest-observable-adverse-effects level
NOAEL = No-observable-adverse-effects level
RME = Reasonable maximum exposure
T&E = Threatened and endangered

assessment and measurement endpoints are formulated to define the specific ecological values to be protected and to define the degree of protection.

Assessment endpoints are statements specifying the desired ecological attribute to be protected in the environment (Suter 1993). For example, wetlands occur at ALAAP, so there is an assessment endpoint for wetlands. Desirable attributes of the environment can be ecosystem functions, such as production and decomposition, or properties such as biodiversity. Valued components of the environment can be organisms and trophic groups with symbolic, commercial, recreational, or ecological importance. Assessment endpoints are often not directly measurable. As a result, one or more measurement endpoints are chosen to determine site-specific impacts on the assessment endpoints.

Decision rules are specified for the assessment endpoints. Table 7-2 shows the decision rules that describe the logical basis for choosing from among alternative actions for the assessment endpoint, based on the results of the measurement endpoints. In some cases, toxicity tests or biotic surveys provide direct evidence of the level of adverse effects. Where these were not conducted, it is assumed that receptor endpoints at ALAAP will exhibit the same level of adverse effects when exposed to a given concentration of a COPEC as that experienced by test species in published toxicity studies. Together, the assessment endpoint, measurement endpoint, and decision rule define an entity (e.g., fish community), a characteristic of the entity (e.g., diversity), an acceptable amount of change in the entity (e.g., no more than a 20 percent reduction in taxonomic diversity compared to a reference site), and a mechanism for deciding whether the protection goal is being met.

Assessment endpoint 1 states that threatened and endangered (T&E) species should not be adversely impacted by potential contamination at ALAAP in accordance with Federal law protecting individuals of T&E species. To evaluate if T&E species are at risk at ALAAP, first the presence of T&E species at ALAAP must be confirmed. Measurement endpoint 1 is thus the published information and field observations indicating that T&E species do not occur in the ALAAP study areas. The decision rule for assessment endpoint 1 specifies that no further evaluation is necessary because no T&E species are present at ALAAP.

Assessment endpoints 2 through 10 state that communities of plants and animals constituting the terrestrial and aquatic ecosystems at the ALAAP study areas should be maintained. Together, these nine assessment endpoints represent policy goals 2 and 3. The measurement endpoints for these assessment endpoints are measured contaminant concentrations in abiotic media (surface soil, surface water, and sediment) and measured or modeled contaminant concentrations in prey animals (rabbits, fish, and crayfish).

Decision rules for assessment endpoints 2 through 10 are given in terms of hazard quotients (HQs) calculated for the SERA and BERA. An HQ is the ratio of the measured or predicted dose or concentration of a substance to which a receptor is exposed in an environmental medium and the measured concentration or dose of a substance causing a specified level of adverse effect on an

organism (i.e., a benchmark or toxicity threshold) (Barnthouse et al. 1986). In the SERA, the HQ is calculated as the ratio of the reasonable maximum exposure (RME) point concentration and the toxicity threshold is equivalent to a no effect concentration (e.g., no-observable-adverse-effect level [NOAEL]). Accordingly, the SERA decision rules for assessment endpoints 2 through 10 are that an HQ < 1 indicates the CEB is not a COPEC. Conversely, an HQ > 1 indicates the substance is a COPEC. In the BERA, the HQ is calculated as the ratio of the average exposure point concentration and a toxicity threshold equivalent to a concentration associated with some level of adverse effect (e.g., lowest-observable-adverse-effect [LOAEL]). Accordingly, the BERA decision rules for assessment endpoints 2 through 10 are that an HQ < 1 indicates the COPEC alone is not a risk. Conversely, an HQ > 1 indicates that the COPEC has some probability of causing an adverse ecological effect on the receptor.

The adverse ecological effects referred to in the decision rules for assessment endpoints 2 through 10 vary. The benchmarks and toxicity thresholds used to calculate HQs, which are associated with some adverse effect, come from laboratory studies of individual substances and test organisms or from field observations on one or more species in different locations. The primary types of adverse ecological effects for assessment endpoints 2 through 10 are given below:

- Assessment endpoint 2 – Root and shoot growth, seed germination for plants (Appendix Table O-27)
- Assessment endpoint 3 – Cocoon production, mortality, growth for soil invertebrates (Appendix Table O-28)
- Assessment endpoints 4, 5, 6, and 10 – Mortality, reproductive effects, growth, organ dysfunction, neurological disorders (Appendix Tables O-29 and O-30) for wildlife species
- Assessment endpoint 7 – Growth, mortality (Appendix Table O-293) for aquatic vegetation
- Assessment endpoint 8 – Various dysfunctions, mortality (Appendix Table O-265) for sediment-dwelling organisms
- Assessment endpoint 9 – Various dysfunctions, mortality (Appendix Table O-293) for aquatic organisms.

The endpoint receptors at ALAAP identified for assessment endpoints 2 through 10 are assumed to experience the same adverse ecological effects as observed in the laboratory or field studies, when they are exposed to the same concentration of contaminant. Policy goals 2 and 3, assessment endpoints 2 through 10, the measurement endpoints, and the SERA and BERA decision rules are presented in Table 7-2.

Assessment endpoint 11 states that wetlands should not be degraded directly or indirectly by the presence of potential contaminants at ALAAP study areas. The potential for wetland degradation depends on the location of wetlands relative to the location and amount of potential contaminants in the study area, and this is reflected in the measurement endpoint for assessment endpoint 11. The decision rule for assessment endpoint 11 is given in terms of the existence of both wetlands in a study area and risk to endpoint species exposed in study area wetland (i.e., violation of assessment endpoints 2 through 10, where appropriate to wetlands).

The final COCs are selected only after additional evaluation of the confidence of exposure assumptions, toxicity thresholds, and other uncertainties (e.g., background risk). The measured concentrations of ALAAP CEBs are provided in Section 4 and Appendix O. The toxicity threshold concentrations are discussed in Section 7.5.

7.4 EXPOSURE ASSESSMENT

The exposure assessment, or Step 2 of EPA's ERA process, describes the following:

- Study areas (Section 7.4.1)
- Habitats in study areas (Section 7.4.2)
- Contaminant sources and exposure media (Section 7.4.3)
- Exposure pathways and food webs (Section 7.4.4)
- Ecological receptors and their exposure at ALAAP (Section 7.4.5)
- Quantification of exposure and exposure factors (Section 7.4.6)
- Summary of exposure assessment (Section 7.4.7).

Each part of exposure to COPECs is presented for each receptor at ALAAP and at background locations.

7.4.1 Selection of Study Areas

ERA study areas are defined as areas where ecological receptors are likely to gather food, seek shelter, reproduce, and move around. Thus, the study areas for the ALAAP ERA were defined on the basis of location of areas with similar exposure media (e.g., surface water or soil); spatial area of study areas relative to the home range and foraging areas of the receptors; and location of areas that may become remedial units. The following terrestrial study areas for the ALAAP ERA are the same as those defined for the ALAAP human health risk assessment:

- Study Area 2 – Smokeless Powder Facility
- Study Area 3 – Sanitary Landfill and Lead Facility
- Study Area 4 – Manhattan Project Area
- Study Area 6 – Southern TNT Manufacturing Area
- Study Area 7 – Northern TNT Manufacturing Area
- Study Area 8 – Acid/Organic Manufacturing Area

- Study Area 10–East – Tetryl Manufacturing Area–East
- Study Area 10–West – Tetryl Manufacturing Area–West
- Study Area 16 – Flashing Ground
- Study Area 17 – Propellant Shipping Area
- Study Area 18 – Blending Tower Area
- Study Area 19 – Lead Facility
- Study Area 20 – Rifle Powder Finishing Area
- Study Area 22 – Demolition Landfill
- Study Area 25 – Storage Battery/Demolition Debris
- *B6 – Building 6 – Coke Oven*
- PO – Downed Utility Poles with Transformers
- PS – *Fertilizer and Pesticide Storage Area*
- Background in northeast part of Area A.

The aquatic study areas are the same as those for the human health risk assessment and consist of the following water bodies:

- Study Area 5 – Red Water Storage Basin
- Study Area 9 –Aniline Sludge Basin
- Study Area 16 – Flashing Ground
- Study Area 21 – Red Water Ditch
- Study Area 26 – Crossover Ditch
- Study Area 27 – Beaver Pond Drainage System
- Coosa River
- Talladega Creek
- Background (Fanning Creek)
- Background (Talladega Creek).

Concentration data for the environmental samples collected during the RI were aggregated by these study areas for soil, surface water, and sediment, and are summarized in Appendix O.

7.4.2 Habitats in Study Areas

There are nine types of habitats (wetlands, ponds, pines, mixed upland hardwoods, bottomland hardwoods, old field early sere, old field, industrial, and other). Section 2.7 provides detailed descriptions of these habitats. **Table 7-3** shows the distribution of approximate acreage among the approximately 770 acres in the study areas. **Figure 7-3** shows the habitat locations within the various study areas as well as among them. Old fields are the most commonly encountered habitat, followed by mixed upland hardwoods.

Table 7-3. Summary of Habitats by Study Area at Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area	Area (acres)	Area (hectares)	Habitats (hectares)								
			Wetlands	Ponds	Pines	Mixed Upland Hardwoods	Bottomland Hardwoods	Old Field (Early Seral State)	Old Field	Industrial	Other*
TERRESTRIAL											
2	90.25	36.52	0.26		0.37	9.43			21.89	1.57	3.00
3	7.51	3.44			0.23	0.93			1.84		0.45
4	3.22	1.30				0.95					0.36
6	74.03	31.19	0.73	0.22	1.84	1.63		24.15			2.61
7	54.32	22.67		0.17	0.77	0.42		20.20	0.35		0.76
8	113.79	46.88	0.89	0.11	14.97	6.29			15.62	6.78	2.22
10E	68.62	27.77			0.59	12.11			8.30		6.77
10W	68.62	27.77			0.59	12.11			8.30		6.77
16	15.03	6.08			1.85	1.28			0.24		2.71
17	126.06	51.66			20.28	18.70			1.26		11.43
18	43.68	17.75				14.79	0.68				2.28
19	4.15	1.71			0.85	0.22					0.63
20	42.31	17.12				6.50	0.19		6.64		3.80
22	1.77	0.76				0.45					0.31
25	2.63	1.50	0.32		0.16	0.89					0.13
B6	0.17	0.07							0.07		
PO	0.15	0.06							0.06		
PS	0.35	0.14							0.14		
Total	**716.65**	**294.40**	**2.21**	**0.50**	**42.50**	**86.67**	**0.87**	**44.35**	**64.70**	**8.35**	**44.23**
AQUATIC											
5	9.28	3.76		0.99		2.79					
9	3.99	1.61		1.62							
21	10.30	4.17		0.05	0.40	0.83		2.92			
26	1.56	0.63			0.02	0.62					
27	27.87	11.28	11.34								
Total	**53.00**	**21.45**	**11.34**	**2.66**	**0.42**	**4.23**	**0.00**	**2.92**	**0.00**	**0.00**	**0.00**
Grand Total	**769.65**	**315.85**	**13.55**	**3.17**	**42.91**	**90.91**	**0.87**	**47.27**	**64.70**	**8.35**	**44.23**

*Other = areas containing various habitat (e.g., patches of bare soil, roads, etc.)

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LEGEND:

- BUILDINGS
- PRIMARY ROADS
- SECONDARY ROADS
- TRAILS
- FENCE
- AREA BOUNDARIES
- RAIL ROAD
- CREEK, TRIBUTARIES AND RIVER
- WETLANDS
- PONDS, IMPOUNDMENTS
- PINES
- MIXED UPLAND HARDWOODS
- BOTTOMLAND HARDWOODS
- OLD FIELD (EARLY SERE)
- OLD FIELD
- INDUSTRIAL
- GRID BASED ON ALABAMA STATE PLANE EAST

NOTES:

1. BASE MAP OF AREA B RECEIVED FROM AIR SURVEY CORPORATION. MAP COMPILED FROM AERIAL SURVEY, FEBRUARY 1995.
2. OUTSIDE AREAS OF BASE MAP RECEIVED FROM AMERICAN DIGITAL CARTOGRAPHY, SCANNED FROM USGS CHILDERSBURG 7.5 MIN. QUADRANGEL DATED 1984, 1" = 100,000'.
3. HABITAT DATA DETERMINED FROM AERIAL SURVEY BY AIR SURVEY CORPORATION. DIGITIZED BY SAIC, NOVEMBER 1995.

0 1400 1800 3600

SCALE: 1" = 1800'

U.S. ARMY ENVIRONMENTAL CENTER
ALABAMA ARMY AMMUNITION PLANT
CHILDERSBURG, ALABAMA

Habitat Map

Figure No.	Project No.	File Name	Date
7-3	01-1033-03-8178-045	99015\DWGS\E42HAB2	03-31-99

7.4.3 Contaminant Source and Exposure Media

Contaminant sources at ALAAP include surface and subsurface soil in the terrestrial study areas and sediment and surface water in the aquatic study areas. The origin, nature, and extent of the contaminants in these media are discussed in Section 4. Contamination in soil at terrestrial units (e.g., Study Areas 8 and 22) has the potential to continually contaminate surface water and sediment in nearby aquatic study areas (e.g., Study Area 9 and Talladega Creek). Hazardous substances emanating from other sources may also contribute to the overall exposure at ALAAP and at background locations. See Section 2 for more information describing the ALAAP surroundings and other potential sources of chemical exposure (e.g., agricultural fields).

Groundwater, air, and subsurface soil (more than 1 foot below land surface [BLS]) were not judged to be significant exposure media for the ALAAP ecological receptors, and thus, were not quantitatively evaluated as part of the ERA. Most animals do not come into contact with groundwater until it emerges as surface water at seeps, springs, or drainage features. Burrowing animals may be exposed to volatile organic and inorganic compounds in their burrows or near the surface of landfills. However, the exposure of animals to chemicals by inhalation is likely to be a small fraction of direct exposure to chemicals in soil by incidental ingestion and indirect exposure by ingestion of contaminated biota. Furthermore, the available toxicity data apply almost exclusively to the ingestion pathway. As a result, the air pathway was not evaluated. Large plants may be exposed to groundwater and subsurface soils. The primary exposure of plants occurs in surface soil (during early life stages); therefore, only shallow exposures were evaluated. Most animal and plant activity occurs in the surface organic layer of soil (A and B horizons), which at ALAAP Area B signifies the upper few inches. Maximum reported burrowing depths for the receptor species present at ALAAP-like habitats are 6 feet for the earthworm and 1.5 feet for the short-tailed shrew (Suter et al. 1993). However, the majority of earthworms reside in the upper 6 inches of soil. Likewise, most sediment-dwelling invertebrates live on the sediment surface or in the oxidized surface layer, which is seldom deeper than a few inches.

The primary exposure media at ALAAP and background locations that are quantitatively evaluated in the ERA are surface soil (0 to 1 foot), sediment (0 to 1 foot), and surface water. In addition, animals such as rabbits, fish, and crayfish can constitute contaminated food for predators. Ecological receptors most frequently are exposed to contaminants in these media. Exposures to these contaminants is modified by the processes of dilution (e.g., normal mixing and dispersion) and magnification (e.g., bioaccumulation) of the concentration of COPECs in the environment.

7.4.4 Exposure Pathways and Food Webs

The pathways from contaminant sources and exposure media through the food web to ecological receptors potentially exposed to ecological COPECs at ALAAP and background locations are presented in **Figure 7-4** and are summarized in **Table 7-4**. Table 7-4 represents a

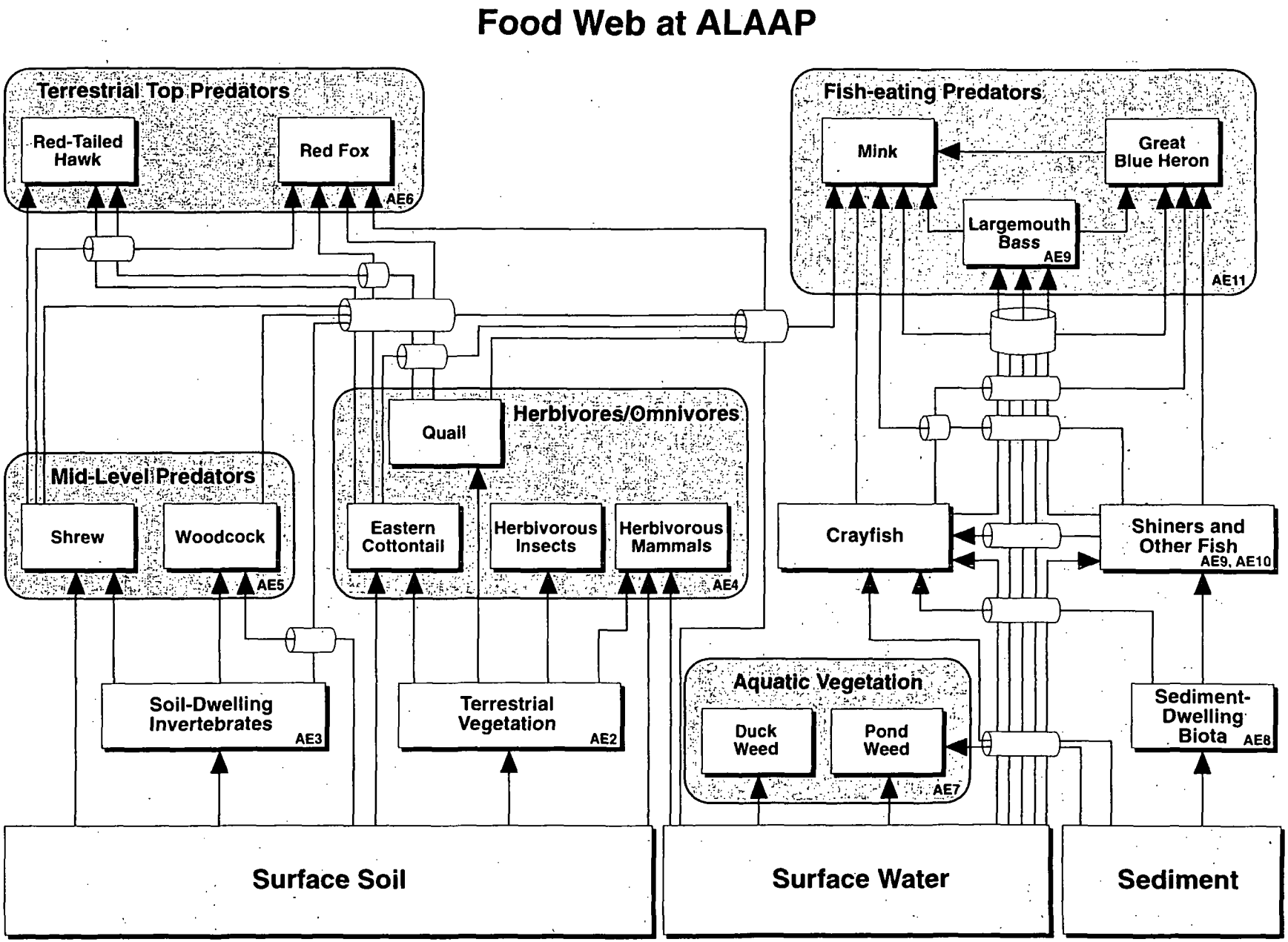

Figure 7-4. Food Web at ALAAP

Table 7-4. Exposure Routes for Alabama Army Ammunition Plant, Childersburg, Alabama BERA

TERRESTRIAL UNITS		EXPOSURE ROUTE			
		Soil			
Exposure Unit	Receptor Class	Direct Contact	Ingestion	Ingestion of Plants	Ingestion of Animals
2 Smokeless Powder Facility					
3 Sanitary Landfill and Lead Facility					
4 Manhattan Project Area	Terrestrial Vegetation	•	—	—	—
6 Southern TNT Manufacturing Area					
7 Northern TNT Manufacturing Area					
8 Acid/Organic Manufacturing Area	Soil-dwelling Invertebrates	•	•	—	—
10E Tetryl Manufacturing Area–East					
16 Flashing Ground					
17 Propellant Shipping Area	Herbivorous Animals	—	•	•	—
18 Blending Tower Area					
19 Lead Facility					
20 Rifle Powder Finishing Area	Insectivorous Mammals and Birds	—	•	—	•
22 Demolition Landfill					
25 Storage Battery/Demolition Debris					
B6 Building 6 – Coke Oven	Top Predators	—	—	—	•
PO Downed Utility Poles					
PS Fertilizer and Pesticide Storage Area					
Background in northeast part of Area A					
AQUATIC UNITS		**EXPOSURE ROUTE**			
		Sediment and Surface Water			
Exposure Unit	Receptor Class	Direct Contact	Ingestion	Ingestion of Plants	Ingestion of Animals
5 Red Water Storage Basin					
9 Aniline Sludge Basin	Aquatic Vegetation	—	—	—	—
16 Flashing Ground					
21 Red Water Ditch	Sediment-dwelling Invertebrates	•	•	—	—
26 Crossover Ditch					
27 Beaver Pond Drainage System	Aquatic Animals	•	•	•	•
Talladega Creek					
Background (Fanning Creek)	Piscivorous Predators	—	—	—	•
Background (Talladega Creek)					

• = Pathway evaluated quantitatively
— = Pathway not evaluated or evaluated qualitatively

more detailed version of the conceptual site model (Figure 7-2). Each closed circle or complete pathway is expressly related to a given receptor class. In turn, the same set of receptors is exposed at each of the study areas. Study areas are listed in one continuous column.

Terrestrial vegetation is exposed to contaminants in surface soil by direct contact. Soil-dwelling invertebrates, such as earthworms, burrow in the surface soil and ingest soil as their primary source of nutrition. Large vertebrate herbivores, such as white-tailed deer, drink from surface water features, and incidentally ingest soil while eating vegetation. Smaller herbivorous mammals, such as rabbits, eat grass and other vegetation, incidentally ingesting soil in the process. Insectivorous mammals, such as shrews, burrow in the soil and eat soil-dwelling invertebrates, such as earthworms and insect larvae, as well as incidental soil. Many insectivorous birds, such as woodcocks, eat earthworms and soil-dwelling insect larvae, as well as incidentally ingesting soil in the process. Mammalian top predators, such as red foxes, eat a mixed diet of invertebrates, fruits and berries, and small birds and mammals. Top predator birds, such as hawks, forage over open areas, hunting small mammals such as rabbit, shrew, mice, and ground-dwelling birds (e.g., quail).

The aquatic habitats at ALAAP (e.g., Beaver Ponds and Crossover Ditch) are suitable for fish and sediment-dwelling invertebrates and for the terrestrial and aquatic predators feeding on them (Figure 7-4). Table 7-4 summarizes aquatic exposure pathways. Floating aquatic plants are exposed to contaminants dissolved in surface water. Rooted aquatic plants are exposed to contaminants in sediment and surface water. Sediment-dwelling invertebrates are exposed primarily to contaminants in sediment by direct contact with sediment pore water and ingestion of sediment. Crayfish are representative of aquatic biota that are exposed to contaminants in sediment and biota. Fish and other aquatic biota living in water are exposed to contaminants in surface water as well as contaminants in the tissues of their prey. Shiners represent small fish that feed on a mixture of sediment-dwelling biota, aquatic invertebrates, and even a small percentage of terrestrial insects that fall into lakes, ponds, and streams. Largemouth bass are typical of larger predatory fish that feed primarily on other smaller fish and the larger aquatic invertebrates (e.g., crayfish). Largemouth bass, shiners, and crayfish are all prey of fish-eating birds, such as the great blue heron, and mammals, such as the mink. Mink also eat terrestrial animals, such as birds, small mammals, and larger invertebrates.

7.4.5 Ecological Receptors and Their Exposure

The risk assessment evaluates the potential exposures of ecological receptors to COPECs in surface soil, sediment, and surface water. In addition, plants and animals are ingested by receptors and are treated as biotic media. Ecological receptors are grouped into exposure classes. Exposure classes contain species with similar feeding habits and physiologies. Each exposure class for the ALAAP ERA has one or more species of ecological receptors.

The terrestrial exposure classes and their ecological receptors for the ALAAP ERA are as follows:

- Vegetation (no specific receptor identified)
- Soil dwelling invertebrates
  - Earthworms
- Herbivorous animals
  - Rabbit
  - Deer
- Insectivorous and worm-eating mammals and birds
  - Shrew
  - Woodcock
- Terrestrial top predators
  - Red fox
  - Red-tailed hawk.

These receptors or their ecological equivalents are present, or likely to be present, at ALAAP and were selected in accordance with *Framework for Ecological Risk Assessment* (EPA 1992a). All receptors are ecologically relevant because they represent major groups of receptors exposed along the pathways leading from the identified source media. All are susceptible to exposure unit COPECs, and toxicity data are available for each receptor to evaluate and predict risk. Exposure classes are defined operationally, and receptors are defined specifically. Their relationship to policy goals is indicated in Section 7.3.5 and in Table 7-2. Receptors and major exposure routes for receptors are provided on the food web in Figure 7-4, and were explained previously.

Each receptor listed is directly linked to one of the assessment endpoints and provides an explicit expression of the environmental value to be protected. For example, soil-dwelling invertebrates are listed because the soil invertebrate community is ecologically important, susceptible to constituents in soil, and exposed at the ALAAP study areas. Similarly, worm-eating and/or insectivorous mammals and birds are ecologically important because they help to control the size of the terrestrial invertebrate population that might otherwise damage populations of primary producers, especially plants. They also are susceptible to soil COPECs and are exposed at the ALAAP study areas. Short-tailed shrews and American woodcock were chosen as surrogate species because they are highly exposed to COPECs by their consumption of large quantities of terrestrial invertebrates present in the habitats at ALAAP. They also ingest soil during feeding, including soil within the bodies of earthworms and other prey.

Exposure pathways were chosen to provide the highest potential exposures to receptors under a variety of conditions. For example, earthworms and shrews constitute a pathway where

exposure of small mammals from soil COPECs would be maximized. Hawks represent the top of the food web where exposures from bioaccumulated materials can be maximal. Each class and specific receptors are discussed further in the following paragraphs. In addition, receptors are profiled according to such attributes as body weight, home range, temporal use factor, and various ingestion rates. All of these parameters are used in this ERA.

Vegetation—Terrestrial plants are exposed to COPECs primarily by direct contact with soil. Vegetation forms the basis of the food web; herbivores eat plants and carnivores, in turn, eat herbivores. It is assumed that plants are exposed to full soil concentration.

Soil-Dwelling Invertebrates—Earthworms (*lumbricids*) and other soil-dwelling invertebrates are exposed to soil chemicals in surface soil by ingestion and direct contact. It is assumed that earthworms ingest only soil and are exposed to the full-measured soil concentration. Earthworms have ecological value because of their role in the decomposition of detritus, soil aeration, and soil fertility. Also, earthworms are ingested by worm-eating mammals and birds and, thus, any decrease of earthworm populations would reduce the amount of food available to their predators and, in turn, could affect such predators. In addition, contaminated earthworms—with contaminated soil in their digestive system and contaminated tissue—can contaminate and affect their mammal and bird predators.

Herbivorous Animals—Herbivorous mammals (e.g., rabbits and deer) and birds (e.g., quail) are exposed primarily through incidental ingestion of contaminated surface soil and of plant material. The eastern cottontail (*Sylvilagus floridanus*) represents mid-sized herbivores in the ERA (**Table 7-5**). The white-tailed deer (*Odocoileus virginianus*) represents the large-sized herbivore (**Table 7-6**). Small mammals at each exposure unit are assumed to obtain everything they ingest from that exposure unit, whereas large mammals are assumed to obtain food from an aggregate of exposure units.

Insectivorous and Worm-eating Mammals and Birds—Insectivorous and worm-eating mammals (e.g., short-tailed shrew, *Blarina brevicauda*) and birds (e.g., American woodcock, *Scolopax minor*) are exposed primarily by ingestion of potentially contaminated prey (e.g., earthworms, insect larvae, slugs) as well as ingestion of soil. Receptor profiles are found in **Tables 7-7** and **7-8**. Direct contact, and especially inhalation of volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs), are not likely to result in significant exposures because these chemicals are expected to have already dissipated. Dermal exposure is minor because both feathers and especially fur serve as effective barriers to the absorption of COPECs. The integument (e.g., skin) also serves as an additional barrier to dermal absorption. Fur and skin-associated soil ingested during grooming was included in the estimated daily soil ingestion rate. For the ALAAP study areas, the exposure for this class of receptors is the sum of materials absorbed from ingested soil, plants and animals. The soil fraction of their diet includes soil from the intestinal tracts of their prey. Exposure by inhalation was not evaluated.

Table 7-5. Receptor Parameters for Eastern Cottontail Alabama Army Ammunition Plant, Childersburg, Alabama

Parameter	Definition	Receptor: Eastern cottontail (*Sylvilagus floridanus*)	
		Value	Reference / Notes
BW	Body weight (kg)	1.23	Arithmetic mean of 4 seasonal means, adult, both sexes, Georgia, all areas (EPA 1993f).
HR	Home range (ha)	3	Arithmetic mean of winter means, adult, both sexes, Wisconsin (EPA 1993f).
TUF	Temporal use factor	1	Will be 1 unless a specific value exists for a receptor.
IR_F	Food ingestion rate (g/g-d = kg/kgBW/d)[a]	0.205	Estimated by dividing free-living metabolic rate (203 kcal/kgBW/d) by the product of the energy composition of young grasses (1.3 kcal/g wet wt.) and assimilation efficiency (0.76) per Figure 4-7 (EPA 1993f).
PF	Plant fraction in diet	1	EPA (1993f); assumed to be vegetative parts.
AF	Animal fraction in diet	0	Not reported in EPA (1993f); assumed to be negligible.
SF	Soil fraction in diet	0.063	Value for jackrabbit, estimated percent soil in diet, dry weight (EPA 1993f).
IR_w	Water ingestion rate (g/g-d = L/kgBW/d)	0.097	Adult, both sexes (EPA 1993f).

[a] Food ingestion rate (g/g-d), re-expressed as kg/kgBW/d, is assumed not to include ingested soil; therefore, PF+AF = 1.0

Table 7-6. Receptor Parameters for White-tailed Deer Alabama Army Ammunition Plant, Childersburg, Alabama

Parameter	Definition	Receptor: White-tailed deer (*Odocoileus virginianus*)	
		Value	Reference / Notes
BW	Body weight (kg)	56.5	Sample and Suter (1994).
HR	Home range (ha)	175	Geometric mean of minimum (59) and maximum (520) reported in Sample and Suter (1994).
TUF	Temporal use factor	1	Will be 1 unless a specific value exists for a receptor.
IR_F	Food ingestion rate (g/g-d = kg/kgBW/d)[a]	0.031	1.74 kg/d (Sample and Suter 1994) converted to g/g-d (=kg/kgBW/d) by dividing by body weight of 56.5 kg.
PF	Plant fraction in diet	1	Exclusively herbivorous (Sample and Suter 1994); assumed to be vegetative parts.
AF	Animal fraction in diet	0	Not reported in Sample and Suter (1994); assumed to be negligible.
SF	Soil fraction in diet	0.02	Sample and Suter (1994).
IR_w	Water ingestion rate (g/g-d = L/kgBW/d)	0.065	3.7 L/d (Sample and Suter 1994) converted to g/g-d (= L/kgBW/d) by dividing by body weight of 56.5 kg.

[a] Food ingestion rate (g/g-d) re-expressed as kg/kgBW/d is assumed not to include ingested soil; therefore, PF+AF = 1.0

Table 7-7. Receptor Parameters for Short-tailed Shrew Alabama Army Ammunition Plant, Childersburg, Alabama

Parameter	Definition	Receptor: Short-tailed shrew *(Blarina brevicauda)*	
		Value	Reference / Notes
BW	Body weight (kg)	0.017	Arithmetic mean of means, both sexes, fall and summer, western Pennsylvania (EPA 1993f).
HR	Home range (ha)	0.36	Maximum, adult female, summer, Michigan (EPA 1993f).
TUF	Temporal use factor	1	Will be 1 unless a specific value exists for a receptor.
IR_F	Food ingestion rate (g/g-d = kg/kgBW/d)[a]	0.56	Arithmetic mean of adults, both sexes, 25°C, Wisconsin (EPA 1993f).
PF	Plant fraction in diet	0.13	June through October, New York (EPA 1993f); assuming vegetative parts and fungi.
AF	Animal fraction in diet	0.87	June through October, New York (EPA 1993f); assuming 100% earthworms.
SF	Soil fraction in diet	0.13	Talmadge and Walton (1993).
IR_w	Water ingestion rate (g/g-d = L/kgBW/d)	0.223	Adult, both sexes, Illinois, lab (EPA 1993f).

[a] Food ingestion rate (g/g-d), re-expressed as kg/kgBW/d, is assumed not to include ingested soil; therefore, PF+AF = 1.0

Table 7-8. Receptor Parameters for American Woodcock Alabama Army Ammunition Plant, Childersburg, Alabama

Parameter	Definition	Receptor: American woodcock *(Scolopax minor)*	
		Value	Reference / Notes
BW	Body weight (kg)	0.197	Arithmetic mean, both sexes, adults (EPA 1993f).
HR	Home range (ha)	32.4	Adult, both, summer, Wisconsin (EPA 1993f).
TUF	Temporal use factor	1	Will be 1 unless a specific value exists for a receptor.
IR_F	Food ingestion rate (g/g-d = kg/kgBW/d)[a]	0.77	Adult, both sexes, winter (EPA 1993f); assumed to be earthworm.
PF	Plant fraction in diet	0	N. Carolina and Alabama in winter, Maine in summer (EPA 1993f).
AF	Animal fraction in diet	1	Invertebrates (EPA 1993f).
SF	Soil fraction in diet	0.104	Estimated percent soil in diet, dry weight, Table 4-4 (EPA 1993f).
IR_w	Water ingestion rate (g/g-d = L/kgBW/d)	0.1	Adult, male and female, estimated (EPA 1993f).

[a] Food ingestion rate (g/g-d), re-expressed as kg/kgBW/d, is assumed not to include ingested soil; therefore, PF+AF = 1.0

Terrestrial Top Predators—Top predators are exposed primarily to COPECs that have accumulated in their prey. Terrestrial top predators (e.g., red fox, *Vulpes vulpes,* and red-tailed hawk, *Buteo jamaicensis*) feed primarily on terrestrial prey. Receptor profiles are found in **Tables 7-9** and **7-10**. Some terrestrial predators, such as the red fox, but not the red-tailed hawk, also may incidentally consume soil. Foxes and hawks are assumed to forage over an area that is large relative to that of a single ALAAP ERA exposure unit, so their exposure includes the fraction of their diet that comes from the contaminated area, which is estimated as a function of the size of the home range relative to the sizes of exposure unit(s). Home ranges are values selected from the literature (e.g., EPA 1993f) based on professional judgment. The selected values are judged to be most appropriate for the site based on an understanding of the ecological characteristics at ALAAP. When more than one published value is deemed appropriate, an intermediate value was chosen. For example, the maximum home range reported for adult female shrews for summer in southern Michigan bluegrass habitat (0.36 ha) was selected because it was intermediate in the range of values for male and female shrews (0.1 to 1.8 ha) in the setting considered most similar to ALAAP habitat.

Selection of the aquatic receptors was facilitated by the results of the ALAAP field work. Methods are described in Section 3, and the results of the fish shocking and seining are provided in **Table 7-11**. Nine species of fish were observed among over 280 specimens. **Table 7-12** shows the results of the stream macroinvertebrate sampling. Numerous taxa were observed among the approximately 540 specimens collected. Both surveys show that there are many species and individuals of aquatic organisms.

The aquatic exposure classes and their ecological receptors for the ALAAP ERA are as follows:

- Vegetation (no specific receptor identified)
- Sediment-dwelling invertebrates
  - Crayfish
- Aquatic animals
  - Golden shiners
- Piscivorous predators
  - Great blue heron
  - Mink.

Aquatic Vegetation—Aquatic plants primarily are exposed by direct contact to COPECs in the surface water or sediment. For the ALAAP ERA, it is assumed that floating plants (e.g., duckweed) would be exposed to the full surface water concentration and that rooted plants (e.g., pondweed) would be exposed to the concentration of COPECs in sediment pore water. Nevertheless, no aquatic vegetation was quantitatively evaluated in the ERA because the readily available toxicity base was so small.

Table 7-9. Receptor Parameters for Red Fox
Alabama Army Ammunition Plant, Childersburg, Alabama

Parameter	Definition	Receptor: Red fox (*Vulpes vulpes*)	
		Value	Reference / Notes
BW	Body weight (kg)	4.69	Arithmetic average of means, both sexes, spring, Illinois (EPA 1993f).
HR	Home range (ha)	596	Adult, female, spring, minimum, Minnesota (EPA 1993f).
TUF	Temporal use factor	1	Will be 1 unless a specific value exists for a receptor.
IR_F	Food ingestion rate (g/g-d = kg/kgBW/d)[a]	0.069	Adult, non-breeding, North Dakota (EPA 1993f).
PF	Plant fraction in diet	0.046	Illinois farm/woods, spring, % wet weight (EPA 1993f); assumed to be reproductive parts.
AF	Animal fraction in diet	0.954	Illinois farm/woods, spring, % wet weight, including unspecified/other (EPA 1993f).
SF	Soil fraction in diet	0.028	Estimated percent soil in diet, dry weight (EPA 1993f).
IR_w	Water ingestion rate (g/g-d = L/kgBW/d)	0.085	Arithmetic mean, adult, both sexes (EPA 1993f).

[a] Food ingestion rate (g/g-d), re-expressed as kg/kgBW/d, is assumed not to include ingested soil; therefore, PF+AF = 1.0

Table 7-10. Receptor Parameters for Red-tailed Hawk
Alabama Army Ammunition Plant, Childersburg, Alabama

Parameter	Definition	Receptor: Red-tailed hawk (*Buteo jamaicensis*)	
		Value	Reference / Notes
BW	Body weight (kg)	1.13	Arithmetic mean, female and male, Michigan (EPA 1993f).
HR	Home range (ha)	697	Mean, adults, both sexes, winter, Michigan (EPA 1993f).
TUF	Temporal use factor	1	Will be 1 unless a specific value exists for a receptor.
IR_F	Food ingestion rate (g/g-d = kg/kgBW/d)[a]	0.11	Adult female, winter, Michigan, captive outdoors (EPA 1993f).
PF	Plant fraction in diet	0	Not stated in EPA (1993f); assumed to be negligible.
AF	Animal fraction in diet	1	Prey brought to nests (EPA 1993f).
SF	Soil fraction in diet	0	Not stated in EPA (1993) and Beyer et al. (1994); assumed to be negligible.
IR_w	Water ingestion rate (g/g-d = L/kgBW/d)	0.057	Arithmetic mean, both sexes, estimated (EPA 1993f).

[a] Food ingestion rate (g/g-d), re-expressed as kg/kgBW/d, is assumed not to include ingested soil; therefore, PF+AF = 1.0

Table 7-11. Results of Fish Sampling at ALAAP: Species Compositions Alabama Army Ammunition Plant, Childersburg, Alabama

Fish Species	Study Areas and Sampling Locations						Sums
	Background	21	26		27	Talladega Creek	
			Crossover Ditch				
	Fanning Branch (near bridge)	Red Water Ditch (elbow)	Lower (SW03)	Upper (SW07)	Beaver Pond (east)	(SW24)	
Bluegill	8	—	3	17	10	5	43
Channel Catfish	—	—	—	—	—	2	2
Golden Shiner	—	47	—	6	35	—	88
Green Sunfish	6	27	12	—	66	—	111
Largemouth Bass	1	—	—	4	—	—	5
Longear Sunfish	—	—	—	—	—	3	3
Redbreast Sunfish	5	—	2	—	—	2	9
Redear Sunfish	1	—	1	5	—	1	8
Warmouth	4	—	—	2	7	—	13
Totals	**25**	**74**	**18**	**34**	**118**	**13**	**282**

Bluegill (15%), golden shiners (31%), and green sunfish (40%) equal 86% of nine species.

Table 7-12. Results of Stream Macroinvertebrate Sampling at ALAAP: Species Compositions Alabama Army Ammunition Plant, Childersburg, Alabama

Macroinvertebrate Taxa	Study Areas and Sampling Locations						Sums
	Background	21	26		27	Talladega Creek	
			Crossover Ditch				
	Fanning Branch (near bridge)	Red Water Ditch (elbow)	Lower (SW03)	Upper (SW07)	Beaver Pond (east)[a]	(SW24)	
Worms	—	24	—	4		1	29
Mollusks							
Clams	1	—	34	—		1	36
Snails	—	—	—	1		4	5
Arthropods							
Flies	14	45	37	15		35	146
Caddisflies	71	1	19	1		16	108
Mayflies	2	2	20	3		60	87
Damselflies	—	50	1	1			52
Stoneflies	15	—	—	—		3	18
All others (dragonflies, beetles, bugs)	21	12	14	12		1	60
Totals	**124**	**134**	**125**	**37**		**121**	**541**

[a] Not stream

Sediment-Dwelling Invertebrates—Sediment-dwelling invertebrates (e.g., crayfish) are assumed to be exposed to sediment and sediment pore water by multiple routes. The toxicity threshold concentrations for COPECs in sediment for the ALAAP ERA are based on all exposure routes from sediment to sediment-dwelling invertebrates. Thus, the measured COPEC concentration in sediment is used as the estimated exposure concentration for sediment-dwelling invertebrates.

Aquatic Animals—Aquatic animals are exposed primarily to COPECs in surface water and in the food they ingest. The exposure concentration in the risk analysis for these animals is assumed to be equal to the measured environmental concentration. It is assumed that, except for sediment-dwelling invertebrates (discussed earlier), aquatic animals are exposed to the full concentration in surface water by direct contact and all other pathways. Although sediment-ingesting fish are exposed to contaminants in both sediment and surface water, there are no known dietary toxicity data for such fish. Therefore, the exposure of sediment-ingesting fish is considered together with the other aquatic animals, and no exposure specific to sediment ingestion is calculated for these receptors.

Piscivorous Predators—Fish-eating predators are exposed primarily to COPECs that have accumulated in their prey. Mink (*Mustela vison*, **Table 7-13**) and great blue herons (*Ardea herodias*, **Table 7-14**) feed on crayfish and other fish species. Mink also feed on some terrestrial animals.

The receptor populations—earthworms, shrews, rabbits, woodcocks, deer, foxes, red-tailed hawks, shiners, crayfish, mink, and great blue herons—serve as representatives of other species potentially exposed by similar pathways to contaminants in surface soil, surface water, sediment, and biota at ALAAP. The exposures of all receptor classes to COPECs from the measured concentrations in the soil, sediment, water, and food, adjusted by exposure factors are estimated in the following sections.

7.4.6 Quantification of Exposure and Exposure Factors

The concentrations of COPECs in exposure media to which ecological receptors at ALAAP and background locations are potentially exposed were quantified for the ERA. The measured RME concentrations of COPECs in soil, surface water, sediment, and biota are used to quantify exposure to ecological receptors. These are the same concentrations used to calculate risk in the human health risk assessment. The RME concentration is the lower of the maximum detected concentration and the upper 95th percentile confidence limit on the mean (UCL_{95}). The RME is a conservative estimate of the central tendency of the distribution of contaminant concentrations in samples, especially in those cases in which the maximum detected concentration is smaller than the UCL_{95}. The measured COPEC concentration data for soil at the terrestrial study areas and for sediment and surface water at the aquatic study areas are summarized in tables preceding the study area-specific risk results by media in Appendix O.

Table 7-13. Receptor Parameters for Mink
Alabama Army Ammunition Plant, Childersburg, Alabama

Parameter	Definition	Receptor: Mink (*Mustela vison*)	
		Value	Reference / Notes
BW	Body weight (kg)	0.795	Arithmetic average, both sexes, adult, summer, Montana (EPA 1993f).
HR	Home range (km)	2.24	Arithmetic average, adult, both sexes, stream, Sweden (EPA 1993f).
TUF	Temporal use factor	1	Will be 1 unless a specific value exists for a receptor.
IR_F	Food ingestion rate (g/g-d = kg/kgBW/d)[a]	0.14	Adult, both sexes, winter, Michigan (EPA 1993f).
PF	Plant fraction in diet	0	Vegetation reported as 1% of gut contents, river, year round, Michigan (EPA 1993f); assumed to be 0.
AF	Animal fraction in diet	1	River, year round, Michigan (EPA 1993f).
SF	Soil fraction in diet	0	Not listed in EPA (1993f); assumed to be 0.
IR_w	Water ingestion rate (g/g-d = L/kgBW/d)	0.105	Arithmetic average, both sexes, adult (EPA 1993f).

[a] Food ingestion rate (g/g-d), re-expressed as kg/kgBW/d, is assumed not to include ingested soil; therefore, PF+AF = 1.0

Table 7-14. Receptor Parameters for Great Blue Heron
Alabama Army Ammunition Plant, Childersburg, Alabama

Parameter	Definition	Receptor: Great blue heron (*Ardea herodias*)	
		Value	Reference / Notes
BW	Body weight (kg)	2.39	Arithmetic mean, adult, both sexes, location not stated (EPA 1993f).
HR	Home range (km)	3.1	Foraging distance, mean, adults, both sexes, South Dakota, stream (EPA 1993f).
TUF	Temporal use factor	1	Will be 1 unless a specific value exists for a receptor.
IR_F	Food ingestion rate (g/g-d = kg/kgBW/d)[a]	0.18	EPA (1993f).
PF	Plant fraction in diet	0	None listed as dietary intake in EPA (1993f).
AF	Animal fraction in diet	1	98% aquatic vertebrates, lower Michigan, river (EPA 1993f).
SF	Soil fraction in diet	0	Not reported in EPA (1993f); assumed to be negligible.
IR_w	Water ingestion rate (g/g-d = L/kgBW/d)	0.045	Estimated (EPA 1993f).

[a] Food ingestion rate (g/g-d), re-expressed as kg/kgBW/d, is assumed not to include ingested soil; therefore, PF+AF = 1.0

Measured COPEC concentrations in terrestrial biota (rabbits) and aquatic biota (crayfish and fish) are used to estimate exposure of terrestrial top predators and piscivorous predators in two ways. First, measured body burdens are used directly to estimate the concentration of COPECs in the food items of predators foraging at the study areas where samples were collected. Second, the ratio of the body burden measurements and measured concentrations of COPECs in abiotic media from sampled study areas are used to estimate the bioaccumulation factors for those COPECs at study areas where no samples were collected. In addition, published bioaccumulation factors were used to derive exposure factors for ecological receptors; estimated ALAAP-specific bioaccumulation factors also were used. Quantification of exposure is further explained in the following section.

Rabbits collected from ALAAP background locations (BR-BK-001; BR-BK-002) and Study Areas 8 (BR-08-001 to -003), 10 (BR-10-001 to -003), 16 (BR-16-001 to -002) and 17 (BR-17-001, -002, and -004) were analyzed for chemicals. Twelve inorganic and three organic contaminants were detected in rabbits from one or more of the study areas. Fish from ALAAP background locations (BF-BK-001 to -010) and Study Areas 21 (BF-21-007 to -011), 26 (BF-26-001 to -011, -013, -015, and -017 to -020), and 27 (BF-27-001 to -010) were analyzed for chemicals. Crayfish were collected from background (BC-BK-001, -002, -004) and Study Areas 26 (BC-26-001 to -004 and -008) and 27 (BC-27-001, -002, -004, and -005). Eleven inorganic and six organic contaminants were detected in fish from one or more study areas (see Section 4).

7.4.6.1 Exposure Variables and Factors

The exposure of an endpoint receptor to a chemical in surface soil, sediment, or surface water at ALAAP was quantified using measured concentrations in the environment and exposure variables/exposure factors (EFs). EFs are estimates of a receptor's exposure per unit concentration of COPEC in the sampled source or exposure medium. Exposure factors numerically represent the dilution and magnification of contaminant concentrations that potentially occur along the pathways from source media to the exposed organism. For example, if a receptor obtains one-half (50 percent) of its food from an area where the soil contains one unit of a substance, the receptor's food bioaccumulates the substance four times over the soil concentration (a Bioaccumulation Factor [BAF] of 4), and the receptor absorbs 100 percent of the substance in the food, the receptor would have an exposure factor of 2 for that contaminant ($0.5 \times 4 \times 1.0 = 2$). The exposure concentration for an endpoint receptor is obtained by multiplying the measured chemical concentration in a given medium (RME concentration) by exposure factors for the endpoint receptor and the COPEC.

Exposure factors are based on published information on diets, the bioaccumulation potential of chemicals, and foraging areas of the receptors. The quantitative exposure parameters used to derive EFs for the endpoint receptors at ALAAP are provided in the food web (Figure 7-4), life

history parameter tables (Tables 7-5 through 7-10, 7-13, and 7-14), and bioaccumulation tables (Appendix O).

7.4.6.2 Home Ranges

In the SERA, the area use factor or the relationship of the area of the unit to the area of the home range is assumed to be 1 for earthworms, cottontail rabbits, shrews, woodcocks, deer, foxes, and hawks; this is true for all terrestrial locations. It also is assumed to be 1 for all sediment-dwelling biota, aquatic biota, mink, and herons at all aquatic portions of the ALAAP study areas.

7.4.6.3 Exposure Equations

Exposure variables and factors for terrestrial receptors are defined for exposures to exposure unit COPECs in soil, sediment, surface water, and the tissues of their prey. The fractions of ingested matter that is soil (SF), animal matter (AF), and plant matter (PF) are summarized in **Table 7-15**. Red-tailed hawk and great blue herons are considered to ingest negligible amounts of plant matter. The estimates of soil ingestion for shrews (0.13) and woodcocks (0.104) are conservative estimates based on the reported fraction of soil in their diets (Talmadge and Walton 1993, EPA 1993f).

Table 7-15. Derivation of Ingestion Rates for Receptors
Alabama Army Ammunition Plant, Childersburg, Alabama

Receptor	IR_F (kg/kgBW/d)	TUF (unitless)	PF (unitless)	I_P (kg/kgBW/d) $IR_F \times TUF \times PF$	AF (unitless)	I_A (kg/kgBW/d) $IR_F \times TUF \times AF$	SF (unitless)	I_S (kg/kgBW/d) $IR_F \times TUF \times SF$
Eastern cottontail	0.205	1	1.00	2.05E-01	0.00	0.00E+00	0.06	1.29E-02
White-tailed deer	0.031	1	1.00	3.10E-02	0.00	0.00E+00	0.02	6.20E-04
Short-tailed shrew	0.560	1	0.13	7.28E-02	0.87	4.87E-01	0.13	7.28E-02
American woodcock	0.770	1	0.00	0.00E+00	1.00	7.70E-01	0.10	8.01E-02
Red fox	0.069	1	0.05	3.17E-03	0.95	6.58E-02	0.03	1.93E-03
Red-tailed hawk	0.110	1	0.00	0.00E+00	1.00	1.10E-01	0.00	0.00E+00
Mink	0.140	1	0.00	0.00E+00	1.00	1.40E-01	0.00	0.00E+00
Great blue heron	0.180	1	0.00	0.00E+00	1.00	1.80E-01	0.00	0.00E+00

IR_F = Food ingestion rate
TUF = Temporal use factor
PF = Plant fraction
I_P = Plant intake rate
AF = Animal fraction
I_A = Animal intake rate
SF = Soil fraction
I_S = Soil intake rate

Exposure equations are presented in the following paragraphs. The general equation is as follows:

Exposure = RME concentration × (Quantity of ingested food adjusted for COPEC Uptake + quantity of soil ingested) × AUF × TUF

where:

RME = Reasonable maximum exposure (mg/kg soil)
AUF = Area use factor, which equals 1 for most receptors (unitless)
TUF = Temporal use factor, which equals 1 (unitless), and, therefore,

TUF does not appear in the following equations because it is a constant of 1.

The equations for groups of terrestrial receptors exposed to COPECs in soil are as follows:

Rabbit and deer: Exposure = RME concentrations × $(SP \times I_P + I_S) \times AUF$

Shrew and woodcock: Exposure = RME concentrations × $(SP \times I_P + BAF_i \times I_A + I_S) \times AUF$

Fox and hawk: Exposure = ([RME soil concentration × $(SP \times I_P + I_s)$] + [RME shrew tissue concentration × (I_A)]) × AUF

where:

RME shrew tissue concentration = shrew exposure × BAF_V/shrew IR_F and,

RME = Reasonable maximum exposure (mg/kg soil)

SP = Soil-to-plant uptake factor (kg soil/kg plant) (see Table O-31)

I_P = Daily ingestion of plant tissue (kg/kg body wt/d) (see Table 7-15)

I_S = Daily ingestion of soil (kg/kg body wt/d) (see Table 7-15)

AUF = Area use factor (unitless) (see Tables 7-18 through 7-20)

BAF_i = Bioaccumulation factor or soil-to-animal uptake factor (kg soil/kg animal) (see Table O-32)

I_A = Daily ingestion of animal tissue (kg/kg body wt/d) (see Table 7-15)

BAF_V = Bioaccumulation factor or animal-to-animal uptake factor (kg animal/ kg animal) (see Table O-32)

IR_F = Total daily ingestion (kg/kg body wt/d) (see Table 7-15).

The equation for sediment-dwelling organisms exposed to COPECs in sediment is as follows:

Exposure = RME concentration

where:

RME = Reasonable maximum exposure (mg/kg sediment)

Likewise, the equation for aquatic organisms exposed to COPECs in water is as follows:

Exposure = RME concentration

where:

RME = Reasonable maximum exposure (mg/L water).

The exposure of mink and great blue herons to COPECs in water was calculated for both ingestion of aquatic food and drinking water as the average daily dose (ADD). Dermal exposure is expected to be minor. The equations are as follows:

For water: Exposure = RME concentration × I_W × AUF

For food: Exposure = RME concentration × BCF × I_A × AUF

where:

RME = Reasonable maximum exposure (mg/L)
BCF = Water-to-animal uptake factor (L/kg tissue)
I_A = Daily ingestion of animal tissue (kg/kg body wt/d)
AUF = Area use factor, which is assumed to be 1 (unitless)
I_W = Daily ingestion of water (L/kg body wt/d).

Body weights for each receptor, ingestion rates, and conversion factors used to calculate dietary exposure are provided in the receptor tables (Tables 7-5 through 7-10, 7-13, and 7-14), and summarized in terms of ingestion rates in Table 7-15. The fraction of the COPEC detected in ingested soil and tissue that is absorbed was assumed to be the same as that determined through laboratory experiments. Continuous year-round exposure was assumed for all receptors. These assumptions are compatible with the conservative nature of the SERA, and these assumptions were endorsed by EPA during the work plan stage.

Benchmarks or toxicity reference values for mammals and birds in Appendix Tables O-29 through O-30 are already expressed in mg/kg BW/d. Thus, the comparison of exposure as average

daily dose and effects as toxicity reference values are in the same units to permit one-to-one comparisons.

The contaminant-specific values for bioaccumulation for soil-to-plant uptake (SP), soil-to-animal (BAF_i), animal-to-animal tissue (BAF_V) and water-to-animal uptake or bioconcentration (BCF) are detailed in Appendix Tables O-31, O-32, and O-266. The BAFs for prey ingested by red foxes and hawks are those for small mammals, and those for herons are the reported BCFs for fish. Default SPs and BAFs for COPECs without published values are 1 for metals and 1 for organics, based on the range of values reported for these types of constituents. Default BCFs are 500 for inorganics and 10,000 for organics based on the same data (HAZWRAP 1994). These defaults are based on professional judgment.

As stated earlier, it is assumed that there is no dilution or concentration of COPECs for earthworms exposed to soil and aquatic receptors exposed directly to sediment and surface water. Therefore, exposure for earthworms and aquatic receptors is equal to the media concentration. When exposures of predators to aquatic prey are modeled, bioconcentration factors are used, as provided in Appendix Tables O-31 and 32.

The RME concentrations used to estimate exposure are provided beginning with Appendix Table O-1 for single study areas and Appendix Table O-19 for aggregated study areas.

7.4.7 Summary of Exposure Assessment

The RME concentrations of COPECs in surface soil, sediment, and surface water at ALAAP are multiplied by exposure factors to estimate exposure concentrations for each endpoint receptor. Exposure factors are an estimate of the exposure of receptors to COPECs on a per-unit-COPEC-concentration basis. Exposure concentrations are the concentrations of COPECs in these abiotic media and their prey to which the endpoint receptors are exposed. These exposure concentrations are compared to published toxicity threshold concentrations (Section 7.5) to characterize the risks to endpoint receptors from direct and indirect exposure to COPECs in environmental media at ALAAP (Section 7.6).

7.5 EFFECTS ASSESSMENT

The purpose of the effects assessment, the third step in EPA's framework for conducting ERAs, is to document and evaluate the effect on and response of ecological receptors to COPECs. This is required to evaluate the assessment endpoints. The effects assessment section for ALAAP includes the following:

- Description of the general adverse effects on receptors from exposure to contaminants (Section 7.5.1)
- Description of the toxicity tests conducted at ALAAP (Section 7.5.2)

- Identification of toxicity thresholds for use in risk quotients (Section 7.5.3).

7.5.1 General Effects of COPECs on Ecological Receptors

Toxic effects on individual organisms can adversely affect receptor populations by decreasing reproduction rates, reducing the viability of offspring, causing alterations in behavior patterns, or increasing susceptibility to disease. Contaminants also may decrease the ability of a population to persist without individual adult organisms suffering any direct lethal effects from exposure to the chemical. These indirect effects are difficult to predict and are not evaluated in the ERA for ALAAP. The ERA focuses on the direct effects of exposure of receptor populations to COPECs in soil, surface water, sediment, and biota. Inorganic elements (metals) and organic compounds, including explosives, qualified as COPECs at ALAAP. The effects of these COPECs on plant and animal receptors at ALAAP are summarized in the following paragraphs. COPECs are CEBs, as shown in Section 4 for each study area.

Metals produce a diversity of adverse physiological and behavioral effects on receptors exposed under natural conditions. The diverse effects of metals on animals usually result from either impairment of kidney function or poisoning of the nervous system. Most inorganic salts of metals (e.g., mercuric sulfide) are toxic to the kidneys; most organometallic forms (e.g., methylmercury) are neurotoxic (Cockerham and Shane 1994). Moreover, the dose-response relationship for a given metal often differs among receptors because of the different abilities of organisms to detoxify the metal or eliminate it from their bodies, as well as the differences in how the receptor interacts with its environment. For example, those organisms with complex mating or foraging behaviors may be adversely affected by a neurotoxic metal at a lower exposure concentration than organisms with less complex behaviors. For example, the egg-laying behavior of mallards is impaired at exposure concentrations of methylmercury that are lower than those that apparently cause no ecological effect on earthworms (Eisler 1987a).

Many organic compounds are reported to cause a wide variety of adverse biological effects under laboratory conditions, including tumors, disruption of metabolism, and reduction of growth and survival. Polycyclic aromatic hydrocarbons (PAHs) have been reported to cause increased liver weights and blood flow to the liver in adults and increased mortality, reduced growth, and increased skeletal and morphological defects in juvenile mallards (Eisler 1987b). PAHs cause genetic, immunopathic, and teratogenic effects in mice.

Explosives and their derivatives detected in soil, sediment, and surface water at ALAAP are organic compounds, but there is less information about their effects on biota than for organics, including pesticides and PAHs. It is assumed that explosives will have similar types of effects on ecological receptors as other organic contaminants.

Unlike human health risk assessment, carcinogenicity of COPECs in animals is of much lesser concern. Although both metals and organic compounds can be carcinogenic to nonhuman

biota, animals with chemical-induced cancers could reproduce before the cancer has progressed sufficiently to kill the organism. Thus, direct impact may be small on the receptor population. Incidence rates of carcinogens would have to be large to adversely affect most populations. The carcinogenicity of COPECs is not considered when establishing effects thresholds for nonhuman endpoint receptors at ALAAP. Rather, the emphasis is on toxicity.

7.5.2 ALAAP Ambient Media Toxicity Tests

Site-specific toxicological studies were conducted to determine whether the concentrations of COPECs in ALAAP media are toxic. The first round was conducted during the Phase 1 Supplemental RI in June 1995 and consisted of Stage I and Stage II. The second round was conducted during Phase 2 in June 1996 and consisted of only one set. Bioassays were conducted in support of the RI under the Army and regulator guidance available at the time and with the consensus of the ALAAP stakeholders. Recent guidance recommends that bioassays be conducted during the BERA, but does not prohibit them in earlier screening-level ERAs. A range of site concentrations was included in the 1995 bioassays (when most bioassays were performed). The approach to the 1996 bioassays (when fewer bioassays were performed) was to identify the highest observed concentrations to increase the range of the 1995 data. Only a few abiotic measurements were available in 1995. Between the 1995 and 1996 bioassays, many more abiotic measurements were taken and, therefore, locations with high concentrations could be identified for the additional bioassays. This 2-year approach provided concentrations ranging from background or reference through intermediate to high.

Two types of terrestrial media toxicity tests were conducted for the ALAAP Area B ERA. Earthworm survival (*Eisenia foetida*) and seed germination (*Arabidopsis thaliana*) tests were conducted at five locations, as shown in Figure 3-6. Sediment and surface water media toxicity tests were conducted at six locations (Figure 3-6) during Phase 1. The sediment toxicity tests consisted of a 10-day, *Hyalella azteca* test that measured survival, according to methodology of the American Society for Testing and Materials (ASTM) (ASTM 1994). The surface water chronic toxicity tests included two procedures following EPA methods (EPA 1989f). The first tests were 7-day, static-daily renewal, larval fathead minnow (*Pimephales promelas*) tests, which measured survival and growth. The second test was a *Ceriodaphnia dubia*, three-brood test, which measured survival and reproduction. More details about the methods are found in Appendix H.

No ecotoxicity was observed in the soil using the two bioassays (**Table 7-16**). Likewise, no ecotoxicity was found in the surface water. The sediment showed slight toxicity during the first set (Stage I) of bioassays. Therefore, only the sediment bioassays were conducted again (Stage II). The second phase bioassays showed no sediment toxicity. See Appendix H for the detailed report.

Table 7-16. Results of ALAAP-Specific Bioassays from June 1995 Alabama Army Ammunition Plant, Childersburg, Alabama

Bioassay	Number of Locations	Major Findings	
		Phase 1	Phase 2
Soil earthworm (14-day)	5	No toxicity	—
Soil seed germination (5-day)	5	No toxicity	—
Surface water *Ceriodaphnia* (7-day)	3	No toxicity	—
Surface water *Pimephales* (7-day)	3	No toxicity	—
Sediment *Hyalella* (10-day)	3	Slight toxicity[1] (June)	No toxicity (August)

— = No need to conduct because Stage 1 was negative
[1] Slight toxicity found at Study Area 21 (elbow) and Study Area 26

A second round of bioassays was conducted in June 1996 (Figure 3-7). They consisted of earthworm survival and seed germination tests and also *Hyalella* and *Ceriodaphnia* tests. They were performed on media taken from places where the maximum concentration of COPECs was located. Results are summarized in **Table 7-17**. See Appendix H for the detailed reports.

Table 7-17. Results of ALAAP-Specific Bioassays from June 1996 Alabama Army Ammunition Plant, Childersburg, Alabama

Bioassay	Number of Locations	Major Findings
Soil earthworm (14-day)	5	Slight toxicity
Soil seed germination (5-day)	5	Slight toxicity
Surface water *Ceriodaphnia* (7-day)	3	Some toxicity
Sediment *Hyalella* (10-day)	3	No toxicity

Findings from these site-specific bioassays added valuable information to the ecological risk assessment. For example, highest observed concentration or dose data from ALAAP toxicity tests were used to derive thresholds for ecological remedial goal options (ecoRGOs) when the observed no-effect concentration was greater than the ecoRGOs based on the published no-effect level. Section 7.10 provides more details on ecoRGOs.

7.5.3 Toxicity Thresholds

The effects assessment for the ALAAP ERA relies on two different types of toxicity information. At some study areas, site-specific subchronic bioassays were used to assess the presence or absence of adverse effects on a few receptors, especially seeds, earthworms, aquatic biota, and sediment-dwelling biota, and to show a no-effect concentration level. For most receptors, published toxicity data were used to evaluate effects from chronic (long-term) exposure and to characterize risk, using risk quotients.

Threshold concentrations were associated with the LOAELs or other low-level effects measurement. Assessment endpoints for the ALAAP ERA are concerned with non-threatened and endangered (non-T&E) species, and thus, are evaluated in terms of effects on individual organisms and populations of receptor species.

7.5.3.1 Soil

Toxicity thresholds for terrestrial plants were obtained from the published compilation literature (Will and Suter 1995a). Toxicity thresholds to evaluate the assessment endpoint for terrestrial vegetation (Assessment endpoint 2) were obtained from the published lowest observed effects concentrations (LOECs) in this data set. These and other terrestrial toxicity thresholds are provided in the risk characterization tables for soil in Appendix Table O-27.

Will and Suter (1995b) provide data on the effects of contaminants on soil invertebrates, especially earthworms, for use as toxicity thresholds. Toxicity thresholds to evaluate the assessment endpoint for soil-dwelling invertebrates (assessment endpoint 3) were obtained from their published LOECs. Toxicity thresholds are provided in the risk characterization tables for soil in Appendix Table O-28.

Toxicity thresholds for animal receptors exposed to COPECs in soil by ingestion of soil or prey were based on published dietary limits for selected wildlife species. The dietary limits for the short-tailed shrew, woodcock, rabbit, deer, and red-tailed hawk (Assessment endpoints 4, 5, and 6) are those reported in Sample et al. (1996) or calculated from COPEC toxicity data published in electronic databases (NLM 1992; NIOSH 1992) using the methods described in Opresko et al. (1995). The published benchmarks values are based on no-observable-adverse-effects levels (NOAELs). These dietary limits are provided in Appendix Tables O-29 and O-30.

7.5.3.2 Sediment

Toxicity thresholds for sediment-dwelling invertebrates were determined in previously published sediment effects thresholds. These "effects levels" are concentrations associated with certain percentages of sediment-associated species experiencing adverse effects. National Oceanic and Atmospheric Administration (NOAA) Effects Range (ER) values were derived using compiled data from independent studies "in which effects were either predicted or observed in association with increasing concentrations" of a substance in sediment (Long and Morgan 1991). The risk to sediment-dwelling invertebrates (Assessment endpoint 8) was evaluated using Effects Range-Low (ER-L) values, which are interpreted as the concentrations above which adverse effects were observed in 5 percent of the reported cases. ER-Ls are provided in the risk characterization tables for sediment in Appendix Table O-265. ER-Ls incorporate exposure of all exposure routes associated with sediment-dwelling invertebrates (Table 7-4). In the absence of ER-Ls, other sediment values are used (see Appendix Table O-265).

Toxicity thresholds for piscivorous predators exposed to COPECs in sediment by ingestion of prey (Assessment endpoint 11) were based on published dietary limits for mink and great blue herons reported in Sample et al. (1996). The published benchmark values are based on NOAELs (Appendix Tables O-29 and O-30).

7.5.3.3 Surface Water

Toxicity benchmarks for aquatic biota exposed to surface water are the National Ambient Water Quality Criteria (NAWQC) chronic or Tier II chronic values, as reported in Suter and Tsao (1996). NAWQC and Tier II values incorporate exposure by all exposure routes associated with aquatic animals (Table 7-4). These thresholds are concentrations associated with protection of aquatic life, but in some cases do not protect all populations from adverse effects. COPECs exceeding the surface water threshold are considered COCs for non-T&E species (Assessment endpoints 7, 9, and 10). Toxicity threshold values for surface water at ALAAP are provided in the risk characterization tables for surface water in Appendix Table O-293.

Toxicity thresholds for terrestrial animals ingesting contaminants in surface water also were used (Sample et al. 1996). These toxicity thresholds were used to evaluate the risk to herbivorous mammals ingesting surface water at ALAAP (Assessment endpoint 4). For some COPECs, the great blue heron had dietary thresholds for the combined exposure to surface water and aquatic prey given in terms of mg/kg BW/d. The effects data are provided in Appendix Tables O-29 and O-30.

Toxicity thresholds for piscivorous predators exposed to COPECs in surface water by ingestion of prey (Assessment endpoint 11) were based on published drinking water limits for great blue herons and mink reported in Sample et al. (1996), which are derived from dietary limits. The published benchmark values are based on NOAELs (Appendix Tables O-29 and O-30).

7.5.4 Body Weight Conversions

Body weight is an integral part of the units of the exposure equations expressed as average daily dose—mg/kg BW/d. Because toxicity is related to metabolic rate, which depends on body weight, toxicity benchmarks can be adjusted to the body weight of the receptor by applying a scaling factor. EPA Region IV provides guidance to exclude body weight conversions from SERAs. By contrast, body-weight conversions are recommended for use in the subsequent BERA. Body-weight conversions add more conservatism to the toxicity reference value (TRV) when the field receptor is larger than the laboratory test organism (e.g., cottontail in field versus mouse in laboratory). The converse, less conservative TRVs, occurs when the field receptor is smaller than the laboratory test organism. Regardless, no body weight conversion was done in the SERA.

7.5.5 Summary of Ecological Effects Assessment

The toxicity of metals and organics, including explosives, is the primary concern at ALAAP. Some metals and organic compounds accumulate in organisms and can have subtle

deleterious effects over long exposure times. Chemicals in the ecosystem may be directly toxic to biota, resulting in sickness, impaired reproduction, or death, thus decreasing the ability of a population to persist.

Toxicity tests of ALAAP soil, surface water, and sediment at selected locations showed no toxicity for soil and water and limited toxicity for sediment in Phase 1 and no toxicity in follow-up studies (Stage II in 1995). By contrast, the second set, conducted during Phase 2 (1996), did show toxicity because samples were taken from the place of highest concentration (not known in 1995). The various doses from a range of media concentrations and the various responses from a range of bioassay results will be used to develop ecoRGOs (see Section 7.10). There is a deliberate range of concentrations with no attempt to limit the concentrations to hot spots. In fact, it is the opposite approach, so that a range of concentrations is obtained between background and maximum concentrations. Within this range of conditions, the dose/response relationship that shows no effect constitutes a lower bound or NOAEL condition. That dose-response relationship that shows a small effect constitutes an upper bound or LOAEL condition. The ecoRGO is an interpolated value between these two conditions.

Note that bioassays are used to develop ecoRGOs for some of the ecological receptors: earthworms (earthworm bioassay) and plants (germination bioassay) in soil, sediment-dwellers (*Hyallela* bioassay) in sediment, and aquatic life (water flea bioassay) in surface water. This is done for COCs (HQs > 1). The above approach is used in setting the ecoRGOs when a particular receptor in these media requires protection.

There are other receptors where a different approach is used. These receptors are small mammals and birds. Here, the approach is not a bioassay approach, but rather a mathematical approach of using the exposure equation for computing the HQ, but to rearrange it and solve for that soil concentration associated with the HQ set at 1. Thus, this is a computed ecoRGO.

The toxicity benchmarks used as effects thresholds for the evaluation of assessment endpoints for shrew, woodcock, rabbit, deer, red-tailed hawk, great blue heron, and mink are dietary limits based on NOAELs for test organisms (Sample et al. 1996).

Sediment-dwelling benthic invertebrates are evaluated initially using ER-Ls. NAWQC chronic and Tier II chronic values, which are associated with protection of aquatic animal exposed by all routes, are toxicity thresholds for non-T&E species exposed to COPECs in surface water.

7.6 RISK CHARACTERIZATION FOR ECOLOGICAL RECEPTORS

Risk characterization, the fourth step in the EPA ERA process, contains the following:

- Integration of exposure point concentrations and effects thresholds on receptor organisms in the assessment endpoints (Section 7.6.1)

- Summarization of risk, and interpretation of the ecological significance of these findings for current (Section 7.6.2) and future (Section 7.6.3) conditions.

Risk characterization compares exposures to effects to estimate the likelihood or risk of harm to plants and animals. The HQs form the quantitative basis of this risk characterization. The use of HQs to calculate the risks to ecological receptors is supported by available guidance (EPA 1991e and 1992f).

7.6.1 Integration of Exposure Point Concentrations and Effects Thresholds

Exposure point concentrations are derived by multiplying the measured environmental concentration (represented by the RME) by the variables in the exposure equations. As explained earlier, the exposure variables and factors incorporate likely adjustments to the measured environmental concentration (e.g., portion of ingestion diet that comes from contaminated prey in a given study area on hawks). The effects information is expressed as the toxicity threshold concentration. Thus, HQs compare the exposure point and toxicity threshold concentrations, as follows:

$$HQ = \frac{\text{Environmental Concentration} \times \text{Exposure Variables}}{\text{Toxicity Threshold Concentration}}$$

Where an HQ could not be calculated because insufficient data were available to establish a toxicity threshold, COPECs are carried through the risk characterization as COPECs of uncertain risk to ecological receptors. Eventually, they are handled as an element of uncertainty and not considered further.

In the SERA (Section 7.6), the HQ is calculated as the ratio of the RME point concentration or dose and the toxicity threshold is equivalent to NOAEL. In general, screening-level HQs > 1 indicate that some individual receptors are potentially exposed at levels that potentially cause an adverse effect of the type measured as the endpoint of the toxicity test from which the NOAEL was derived. Further, a screening-level HQ $\leq$ 1, according to EPA guidance (EPA 1997a), indicates the substance alone is unlikely to cause adverse ecological effects. While there is uncertainty about the true value of both concentrations used in the HQ, screening-level HQs calculated in this way are accepted by EPA as conservative. The use of these HQs as decision criteria for screening-level risk assessments (i.e., an HQ > 1 means the substance is a COPEC) is appropriate and reasonable because the penalty for being too conservative (further evaluation of substance) will typically be less than the potential cost of not correctly identifying a substance as a COPEC when in fact it is a COPEC (unremediated risk).

In the BERA (Section 7.7), the HQ is calculated as the ratio of the average exposure point concentration or dose and a toxicity threshold equivalent to a concentration or dose associated with some level of adverse effect (LOAEL). In general, baseline HQs $\geq$ 1 indicate that some individual

receptors are likely exposed at levels that caused an adverse effect of the type measured as the endpoint of the toxicity test from which the LOAEL was derived. Stated another way, an HQ $\geq$ 1 indicates that the COPEC has some probability of causing an adverse effect on the receptor. Conversely, an HQ < 1 suggests the substance is unlikely to cause adverse effects. The use of baseline HQs to characterize risk is acceptable in a weight of evidence type of approach (EPA 1998a). According to EPA guidance, it is important to consider the uncertainty in the baseline HQ before a decision is made to identify a substance as a COC. If HQs are interpreted strictly by regulators (i.e., if HQ $\geq$ 1 means that there is unacceptable risk), the uncertainties in the HQ are neglected by the decisionmakers, and the regulator-approved exposure levels (i.e., mean) and threshold levels (i.e., LOAEL) define the maximum acceptable adverse effect and the maximum acceptable probability that an individual experiences that effect (Burns, et al. 1998).

There is uncertainty about the true value of both concentrations used to calculate HQs, and thus the HQ itself. Exposure estimates are uncertain because of sampling bias, measurement error, and error in receptors' exposure parameters, such as diet, body weight, and ingestion rates, and error in contaminant absorption efficiencies and bioaccumulation factors. Effect thresholds are uncertain because of differences between benchmarks for test species and receptors, differences between tested forms of substances and the forms present in the environment, and measurement or test errors. The uncertainty about the true value of an HQ implies that some calculated HQs < 1 underestimate the risk and other HQs > 1 overestimate the risk.

As a result of these uncertainties, the true value of the HQ for a given substance and receptor at a particular study area lies in a range of values around the calculated HQ. Although the size of this range or "gray area" varies for different COPECs and receptors and is difficult to quantify, the more the calculated HQ exceeds 1 the more likely the true HQ value also exceeds 1. This fact motivates a focus on HQs $\geq$ 10 to reduce the likelihood of a false positive error—concluding that there is a risk when there is not—because of the cost involved in FSs and remediation. The focus on HQs $\geq$ 10 is meant to balance the suspected but unquantified sources of conservative bias in exposure estimates (e.g., overestimated bioavailability and absorption efficiency, conservative diets, and area use factors). Given the conservative bias inherent to calculated HQs for the ALAAP study areas, HQs < 1 can be safely ignored.

In addition to the computation of HQs to show ecological risk, the hazard index (HI) was computed. The definition of an HI is the sum of all individual HQs for COPECs that have similar toxicological effects (e.g., neural, immunological, excretory, or organ). In the ERA, a more conservative approach was taken. The sum of all HQs, regardless of toxicological effect, was used as the HI. Therefore, if the HI does not exceed a threshold, the HI for a single toxicological effect also cannot exceed the same threshold. In SERAs, any HI greater than 1 means that ecological risk may be unacceptable and that a BERA should follow. By contrast, an HI less than 1 means risks are acceptable. Although there is no known EPA policy on HI magnitudes and corresponding nominal levels of risk, the decision threshold of an HI of 1 remains sufficient to define unacceptable ecological risk for a SERA, suggesting that a BERA should be conducted. This approach is conservative because the modes of action are not all the same. The HIs reflect the number of

COPECs; e.g., the more COPECs, the greater the likelihood that the HI >1. As explained earlier, the AUFs were set at 1 (**Table 7-18**). This was part of the conservative approach used in the SERA.

Exposure and risks to receptors foraging over large areas relative to individual ALAAP study areas were estimated by aggregating the exposures of the receptors to soil COPECs over multiple study areas. This was the case for white-tailed deer, red fox, and red-tailed hawks at ALAAP. To evaluate the worst-case scenarios for these receptors, adjacent ALAAP study areas were aggregated around the study areas having the highest area-weighted COPEC concentrations (i.e., area × RME concentration). For example, Study Area 2 has the highest area-weighted RME concentrations of aluminum, beryllium, 2,4-DNT, and four other COPECs; therefore, aggregated study areas were formed around the study area. The study areas around which the aggregates were formed include Study Areas 2 and 3, Study Areas 8 and 10, Study Area 17, and Study Areas 16 and 19.

Due to the difference in home ranges between the deer (175 ha) and the red fox and hawk (596 ha and 697 ha, respectively), two distinct sets of aggregates were identified around the high-weighted COPEC concentration study areas. Four aggregated study areas were evaluated for the deer:

- 2, 3, 20, B6, PS
- 7, 8, 10, 25, P6, PS
- 16, 19, 22
- 17, 18, PS (**Figure 7-5**).

Three aggregate units were evaluated for the red fox and red-tailed hawk:

- 2, 3, 4, 6, 18, 20, B6
- 6, 7, 8, 10, 17, 18, 20, 25/PO
- 16, 17, 19, 22 (**Figure 7-6**).

The deer has more aggregate units comprising fewer study areas than the red fox and hawk because the home range of the deer is smaller. Regardless, AUFs were set at 1 (**Table 7-19**).

The AUFs for the great blue heron and mink also were set at 1 (**Table 7-20**). The SERA was based on conservative assumptions. By contrast, the BERA used AUFs fitted to the ALAAP situation.

7.6.2 Current Ecological Risks Associated with the SERA

Current screening risk to ecological receptors exposed to ALAAP media are presented in this section. The summary tables for soil, sediment and surface water are based on the tables in Appendix O.

Table 7-18. Area Use Factors (AUFs) for Terrestrial Receptors
Alabama Army Ammunition Plant, Childersburg, Alabama

		AUF - Screen									
		Study Area 2	Study Area 3	Study Area 4	Study Area 6	Study Area 7	Study Area 8	Study Area 10E	Study Area 10W	Study Area 16	Study Area 17
Receptor	HR ha	Area ha = 36.5 (90.25 ac)	Area ha = 3 (7.51 ac)	Area ha = 1.3 (3.22 ac)	Area ha = 30 (74.03 ac)	Area ha = 22 (54.32 ac)	Area ha = 46.1 (113.79 ac)	Area ha = 25.25 (68.62 ac)	Area ha = 25.25 (68.62 ac)	Area ha = 6.1 (15.03 ac)	Area ha = 51 (126.06 ac)
Eastern cottontail	3.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Short-tailed shrew	3.60E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
American woodcock	3.24E+01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00

		AUF - Screen								
		Study Area 18	Study Area 19	Study Area 20	Study Area 22	Study Area 25	Study Area B6	Study Area PO	Study Area PS	Study Area BK
Receptor	HR ha	Area ha = 17.7 (43.68 ac)	Area ha = 1.7 (4.15 ac)	Area ha = 17.1 (42.31 ac)	Area ha = 0.7 (1.77 ac)	Area ha = 1.1 (2.63 ac)	Area ha = 0.07 (.18 ac)	Area ha = 0.06 (.14 ac)	Area ha = 0.14 (.34 ac)	Length of Background exceeds HR
Eastern cottontail	3.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Short-tailed shrew	3.60E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
American woodcock	3.24E+01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00

		AUF - Baseline									
		Study Area 2	Study Area 3	Study Area 4	Study Area 6	Study Area 7	Study Area 8	Study Area 10E	Study Area 10W	Study Area 16	Study Area 17
Receptor	HR ha	Area ha = 36.5 (90.25 ac)	Area ha = 3 (7.51 ac)	Area ha = 1.3 (3.22 ac)	Area ha = 30 (74.03 ac)	Area ha = 22 (54.32 ac)	Area ha = 46.1 (113.79 ac)	Area ha = 25.25 (68.62 ac)	Area ha = 25.25 (68.62 ac)	Area ha = 6.1 (15.03 ac)	Area ha = 51 (126.06 ac)
Eastern cottontail	3.00E+00	1.00E+00	1.00E+00	4.33E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Short-tailed shrew	3.60E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
American woodcock	3.24E+01	1.00E+00	9.26E-02	4.01E-02	9.26E-01	6.79E-01	1.00E+00	7.79E-01	7.79E-01	1.88E-01	1.00E+00

		AUF - Baseline								
		Study Area 18	Study Area 19	Study Area 20	Study Area 22	Study Area 25	Study Area B6	Study Area PO	Study Area PS	Study Area BK
Receptor	HR ha	Area ha = 17.7 (43.68 ac)	Area ha = 1.7 (4.15 ac)	Area ha = 17.1 (42.31 ac)	Area ha = 0.7 (1.77 ac)	Area ha = 1.1 (2.63 ac)	Area ha = 0.07 (.18 ac)	Area ha = 0.06 (.14 ac)	Area ha = 0.14 (.34 ac)	Length of Background exceeds HR
Eastern cottontail	3.00E+00	1.00E+00	5.67E-01	1.00E+00	2.33E-01	3.67E-01	2.33E-02	2.00E-02	4.67E-02	1.00E+00
Short-tailed shrew	3.60E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.94E-01	1.67E-01	3.89E-01	1.00E+00
American woodcock	3.24E+01	1.00E+00	3.24E+01	3.24E+01	3.24E+01	3.24E+01	3.24E+01	3.24E+01	3.24E+01	1.00E+00

AUF (in baseline) = Fraction of receptor exposure from the unit = area of unit/ area of HR; AUF = 1 when area of unit exceeds area of HR
HR = Home range

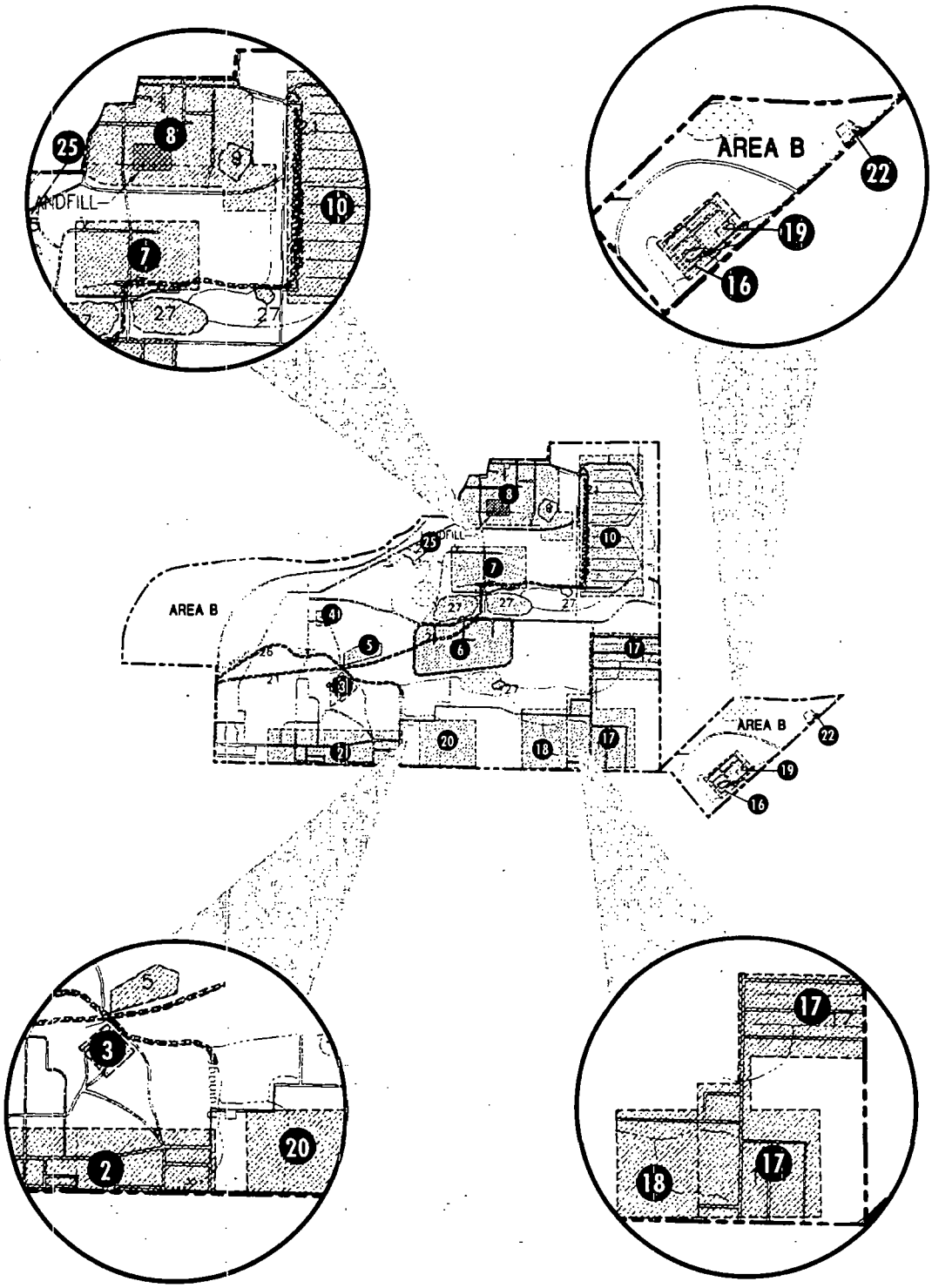

Figure 7-5. Home Ranges of Deer Relative to Various Study Areas

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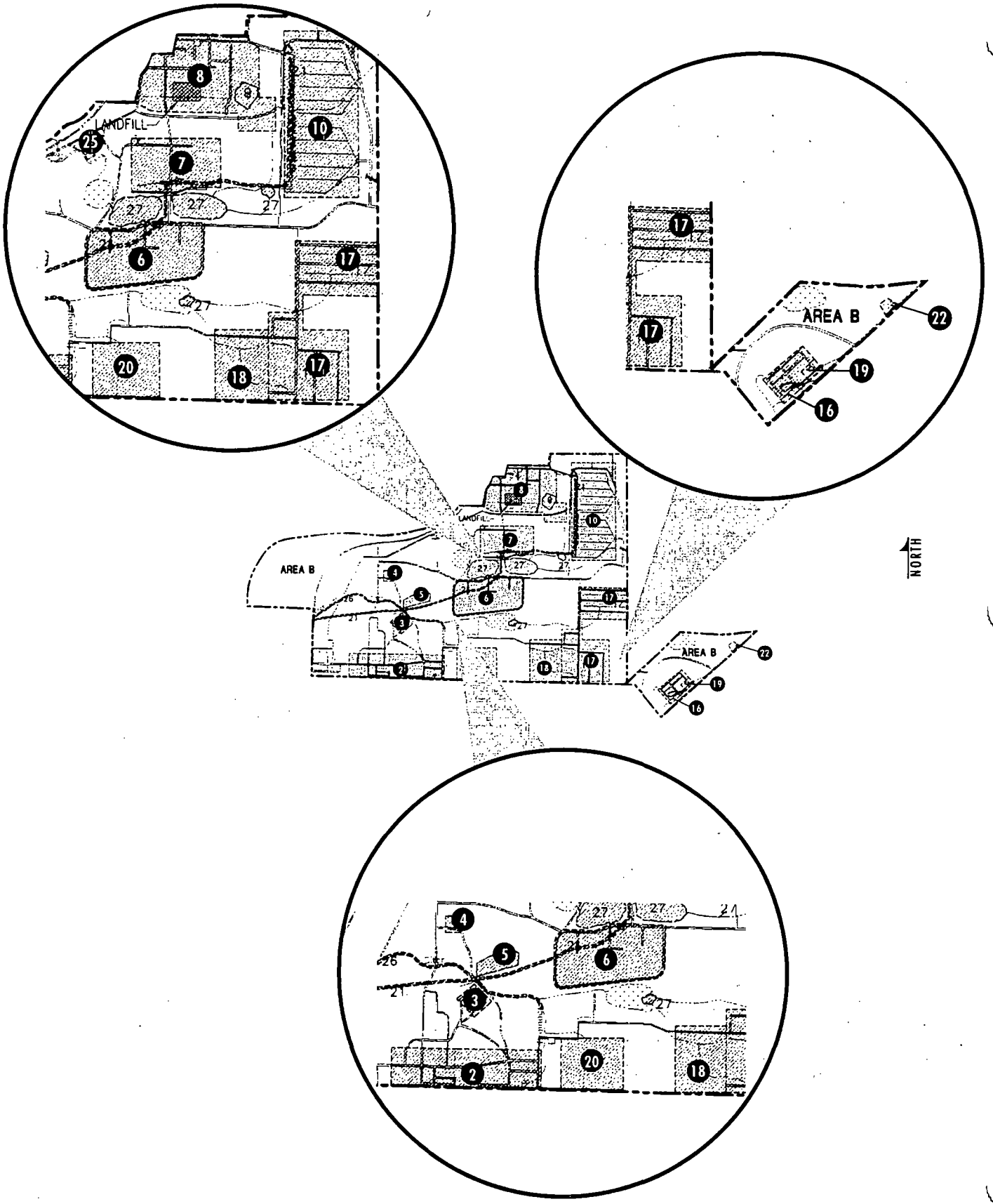

Figure 7-6. Home Ranges of Hawk and Fox Relative to Various Study Areas

Table 7-19. Area Use Factors (AUFs) for Ecological Receptors With Large Home Ranges
Alabama Army Ammunition Plant, Childersburg, Alabama

			Aggregated AUFs - Baseline						
		BK	2, 3, 20, B6, PS	7, 8, 10, 25, PO, PS	16, 19, 22	17, 18, PS	2, 3, 4, 6, 18, 20, B6	6, 7, 8, 10, 17, 18, 20, 25, PO	16, 17, 19, 22
Receptor	HR ha	Length of Background exceeds HR	Area ha = 56.81 (140.3 ac)	Area ha = 119.9 (296.3 ac)	Area ha = 8.5 (21 ac)	Area ha = 68.84 (170 ac)	Area ha = 105.67 (260.8 ac)	Area ha = 240.56 (594 ac)	Area ha = 59.5 (146.97 ac)
White-tailed deer	1.75E+02	1.00E+00	3.25E-01	6.85E-01	4.86E-02	3.93E-01	NA	NA	NA
Red fox	5.96E+02	1.00E+00	9.53E-02	2.01E-01	1.43E-02	1.16E-01	NA	NA	NA
Red-tailed hawk	6.97E+02	1.00E+00	NA	NA	NA	NA	1.52E-01	3.45E-01	8.54E-02

AUF = Fraction of receptor exposure from the unit = area of unit/ area of HR; AUF = 1 when area of unit exceeds area of HR.
HR = Home range
AUF = 1 for earthworm, cottontail, shrew, robin, and woodcock at all terrestrial Study Areas and for sediment-dwelling biota, aquatic biota mink and heron at all aquatic Study Areas.
Aggregate Study Areas 2, 3, 20, B6, PS; Area ha = 36.5 ha (Study Area 2) + 3.0 ha (Study Area 3) + 17.1 ha (Study Area 20) + 0.07 ha (Study Area B6) + 0.14 (Study Area PS) = 56.81 ha
Aggregate Study Areas 7, 8, 10, 25, PO, PS; Area ha = 22 ha (Study Area 7) + 46.1 ha (Study Area 8) + 50.5 ha (Study Areas 10E&10W) + 1.1 ha (Study Area 25) + 0.06 ha (Study Area PO) + 0.14 ha (Study Area PS) = 119.9 ha
Aggregate Study Areas 16, 19, 22; Area ha = 6.1 ha (Study Area 16) + 1.7 ha (Study Area 19) + 1.77 ha (Study Area 22) = 8.5 ha
Aggregate Study Areas 17, 18, PS; Area ha = 51.0 ha (Study Area 17) + 17.7 ha (Study Area 18) + 0.14 ha (Study Area PS) = 68.84 ha
Aggregate Study Areas 2, 3, 4, 6, 18, 20, B6; Area ha = 36.5 ha (Study Area 2) + 3.0 ha (Study Area 3) + 1.3 ha (Study Area 4) + 30.0 ha (Study Area 6) + 17.7 ha (Study Area 18) + 17.1 ha (Study Area 20) + 0.07 ha (Study Area B6) = 105.67
Aggregate Study Areas 6, 7, 8, 10, 17, 18, 20, 25, PO; Area ha = 30.0 ha (Study Area 6) + 22.0 ha (Study Area 7) + 46.1 ha (Study Area 8) + 55.5 ha (Study Area 10E&10W)
+ 51 ha (Study Area 17) + 17.7 ha (Study Area 18) +17.1 ha (Study Area 20) + 1.1 ha (Study Area 25) + 0.06 ha (Study Area PO) = 240.56 ha
Aggregate Study Areas 16, 17, 19, 22; Area ha = 6.1 ha (Study Area 16) + 51.0 ha (Study Area 17) + 1.7 ha (Study Area 19) + 0.7 ha (Study Area 22) = 59.5 ha
NA = not applicable

Table 7-20 Area Use Factors (AUFs) for Aquatic Receptors
Alabama Army Ammunition Plant, Childersburg, Alabama

		AUF - Baseline							
		Study Area 9*	Study Area 16*	Study Area 21*	Study Area 26*	Study Area 27*	Study Area CO*	Study Area TA*	Study Area BK*
Receptor	HR km	Length km = 0.8 (x mi)	Length km = 0.8 (x mi)	Length km = 4.0 (x mi)	Length km = 11.0 (x mi)	Length km = 4.1 (x mi)	Length km = 10.2 (x mi)	Length km = 12.8 (x mi)	Length of Background exceeds HR
Great blue heron	3.10E+00	2.58E-01	2.58E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Mink	2.24E+00	3.57E-01	3.57E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00

AUF = Fraction of receptor exposure from the unit = length of unit/ HR defined as length of stream use; AUF=1 when length of unit exceeds length of HR.
HR = Home range or foraging distance
* Reach of stream or creek adjacent to terrestrial EI Site

7.6.2.1 Screening Level Ecological Risks Associated with ALAAP Surface Soils

Eighteen study areas and one background area (BK) were chosen for the investigation of surface soils at ALAAP. Background is discussed in Section 7.7.5. There is the potential for adverse effects (HQ >1) to ecological receptors exposed to surface soil in all 18 of the study areas investigated in the SERA (Appendix Tables O-33 through O-138). **Table 7-21** provides a summary of the SERA for vegetation, earthworms, cottontail, shrew, and woodcock.

Most of the risk is from inorganics (metals). Fourteen metals, six organics, and one explosive had an HQ >1 for at least one receptor in at least one study area. The range of HQs for these COPECs are listed in the following:

- ***Aluminum***—HQ = 22 to 1,740
- ***Arsenic***—HQ = 2 to 28
- ***Barium***—HQ = 1 to 20
- ***Cadmium***—HQ = 1 to 188
- ***Chromium***—HQ = 9 to 268
- ***Cobalt***—HQ = 1 to 155
- ***Copper***—HQ = 1 to 32
- ***Lead***—HQ = 1 to 3,880
- ***Manganese***—HQ = 1 to 8
- ***Mercury***—HQ = 1 to 5
- ***Molybdenum***—HQ = 2 to 22
- ***Nickel***—HQ = 2 to 367
- ***Vanadium***—HQ = 1 to 52
- ***Zinc***—HQ = 1 to 435
- ***Acenaphthene***—HQ = 2
- ***Aroclor-1248***—HQ = 1,510 to 4,390
- ***Aroclor-1254***—HQ = 31 to 1,010
- ***Benzo(a)pyrene***—HQ = 1 to 9
- ***Benzoic acid***—HQ = 2
- ***Pyrene***—HQ = 3
- ***2,4,6-trinitrotoluene (TNT)***—HQ = 1.

Aluminum, lead, Aroclor-1248, and Aroclor-1254 are the only COPECs with HQ >1,000. Cadmium, chromium, cobalt, nickel, and zinc have maximum HQs between 100 and 1,000. Maximum HQs are between 10 and 100 for arsenic, barium, copper, molybdenum, and vanadium, depending in part on the particular study area and receptor. The maximum HQ was <10 for manganese, mercury, TNT, and the remaining organic COPECs.

Table 7-21. Summary of Surface Soil COPECs (HQ >1) for ALAAP – Screen Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area	Range of Hazard Quotients			
	1 – 9	10 – 99	100 – 999	>1,000
2	Arsenic (2) vegetation Arsenic (2) cottontail Barium (1) cottontail Barium (4) shrew Barium (1) woodcock Lead (4) vegetation Manganese (3) vegetation Manganese (1) shrew Mercury (1) vegetation Vanadium (4) cottontail Vanadium (1) woodcock Zinc (4) vegetation Zinc (1) earthworm Zinc (1) shrew Acenaphthene (2) vegetation Benzo(a)pyrene (1) cottontail Benzo(a)pyrene (9) shrew Pyrene (3) vegetation Pyrene (3) earthworm	Aluminum (32) woodcock Arsenic (13) shrew Chromium (97) vegetation Chromium (20) woodcock Lead (26) shrew Vanadium (32) vegetation Vanadium (41) shrew Zinc (22) woodcock	Aluminum (514) vegetation Aluminum (174) cottontail Chromium (242) earthworm Lead (286) woodcock	Aluminum (1,460) shrew
3	Arsenic (4) vegetation Arsenic (5) cottontail Barium (1) cottontail Barium (5) shrew Barium (1) woodcock Cobalt (1) vegetation Cobalt (4) cottontail Copper (1) earthworm Lead (6) vegetation Vanadium (5) cottontail Vanadium (1) woodcock	Aluminum (36) woodcock Arsenic (26) shrew Lead (42) shrew Vanadium (40) vegetation Vanadium (52) shrew	Aluminum (580) vegetation Aluminum (197) cottontail Cobalt (155) shrew Lead (459) woodcock	Aluminum (1,640) shrew
4	Barium (4) shrew Lead (4) earthworm Lead (3) cottontail Zinc (4) vegetation Zinc (1) earthworm Zinc (1) shrew	Aluminum (35) woodcock Lead (36) vegetation Zinc (21) woodcock	Aluminum (559) vegetation Aluminum (189) cottontail Lead (236) shrew	Aluminum (1,580) shrew Lead (2,580) woodcock
6	Lead (1) shrew TNT (1) shrew	Lead (16) woodcock	None	None
7	Lead (3) shrew TNT (1) shrew	Lead (33) woodcock	None	None

Table 7-21. Summary of Surface Soil COPECs (HQ >1) for ALAAP – Screen Alabama Army Ammunition Plant, Childersburg, Alabama (Continued)

Study Area	Range of Hazard Quotients			
	1 – 9	10 – 99	100 – 999	>1,000
8	Arsenic (2) vegetation Arsenic (3) cottontail Barium (4) shrew Cobalt (1) vegetation Cobalt (3) cottontail Copper (2) vegetation Copper (3) earthworm Copper (2) shrew Lead (8) vegetation Manganese (4) vegetation Manganese (2) shrew Molybdenum (5) vegetation Molybdenum (2) woodcock Nickel (4) cottontail Vanadium (5) cottontail Vanadium (1) woodcock Zinc (6) vegetation Zinc (2) earthworm Zinc (2) shrew	Aluminum (22) woodcock Arsenic (15) shrew Lead (52) shrew Molybdenum (22) shrew Nickel (55) earthworm Nickel (51) shrew Nickel (37) woodcock Vanadium (38) vegetation Vanadium (49) shrew Zinc (31) woodcock	Aluminum (350) vegetation Aluminum (119) cottontail Aluminum (993) shrew Cobalt (120) shrew Lead (563) woodcock Nickel (367) vegetation	None
10E	Arsenic (2) vegetation Arsenic (2) cottontail Barium (4) shrew Lead (5) shrew Manganese (8) vegetation Manganese (1) cottontail Manganese (4) shrew Benzoic acid (2) shrew	Arsenic (11) shrew Lead (53) woodcock	None	None
10W	Lead (9) vegetation	Lead (61) shrew	Lead (667) woodcock	
16	Arsenic (3) vegetation Arsenic (3) cottontail Barium (2) cottontail Barium (7) shrew Barium (2) woodcock Cadmium (2) earthworm Cadmium (1) cottontail Cobalt (1) vegetation Cobalt (3) cottontail Copper (4) cottontail Copper (7) woodcock Lead (4) earthworm Lead (4) cottontail Mercury (5) vegetation Mercury (1) woodcock Nickel (2) vegetation Vanadium (5) cottontail Vanadium (1) woodcock Zinc (4) vegetation Zinc (1) shrew	Aluminum (30) woodcock Arsenic (16) shrew Cadmium (64) vegetation Copper (16) vegetation Copper (32) earthworm Copper (21) shrew Lead (40) vegetation Vanadium (39) vegetation Vanadium (51) shrew Zinc (18) woodcock	Aluminum (480) vegetation Aluminum (163) cottontail Cadmium (174) shrew Cadmium (188) woodcock Cobalt (140) shrew Lead (264) shrew	Aluminum (1,360) shrew Lead (2,890) woodcock

Table 7-21. Summary of Surface Soil COPECs (HQ >1) for ALAAP – Screen Alabama Army Ammunition Plant, Childersburg, Alabama (Continued)

Study Area	Range of Hazard Quotients			
	1 – 9	10 – 99	100 – 999	>1,000
17	Arsenic (5) vegetation Arsenic (5) cottontail Barium (1) cottontail Barium (4) shrew Barium (1) woodcock Manganese (5) vegetation Manganese (2) shrew	Aluminum (36) woodcock Arsenic (28) shrew	Aluminum (580) vegetation Aluminum (197) cottontail	Aluminum (1,640) shrew
18	Arsenic (4) vegetation Arsenic (5) cottontail Lead (3) shrew Manganese (4) vegetation Manganese (2) shrew Vanadium (5) cottontail Vanadium (1) woodcock	Arsenic (25) shrew Chromium (81) vegetation Chromium (16) woodcock Lead (34) woodcock Vanadium (38) vegetation Vanadium (50) shrew	Chromium (202) earthworm	None
19	Lead (1) vegetation Lead (8) shrew Zinc (4) woodcock	Chromium (22) woodcock Lead (89) woodcock	Chromium (107) vegetation Chromium (268) earthworm	None
20	Arsenic (2) vegetation Arsenic (2) cottontail Barium (2) shrew	Aluminum (28) woodcock Arsenic (13) shrew Chromium (66) vegetation Chromium (14) woodcock	Aluminum (449) vegetation Aluminum (152) cottontail Chromium (166) earthworm	Aluminum (1,270) shrew
22	Barium (3) vegetation Barium (5) cottontail Barium (5) woodcock Copper (3) cottontail Copper (4) woodcock Lead (5) earthworm Lead (5) cottontail Mercury (2) vegetation Nickel (3) vegetation Zinc (2) cottontail	Barium (20) shrew Cadmium (24) vegetation Cadmium (65) shrew Cadmium (70) woodcock Chromium (96) vegetation Chromium (20) woodcock Copper (10) vegetation Copper (20) earthworm Copper (14) shrew Lead (54) vegetation Zinc (86) vegetation Zinc (22) earthworm Zinc (26) shrew	Chromium (240) earthworm Lead (354) shrew Zinc (435) woodcock	Lead (3,880) woodcock
25	Arsenic (2) vegetation Arsenic (2) cottontail Lead (1) vegetation Lead (7) shrew Vanadium (5) cottontail Vanadium (1) woodcock Zinc (5) vegetation Zinc (1) earthworm Zinc (2) shrew Benzoic Acid (1) shrew	Aluminum (34) woodcock Arsenic (12) shrew Chromium (56) vegetation Chromium (11) woodcock Lead (74) woodcock Vanadium (39) vegetation Vanadium (50) shrew Zinc (27) woodcock	Aluminum (540) vegetation Aluminum (183) cottontail Chromium (139) earthworm	Aluminum (1,530) shrew

Table 7-21. Summary of Surface Soil COPECs (HQ >1) for ALAAP – Screen Alabama Army Ammunition Plant, Childersburg, Alabama (Continued)

Study Area	Range of Hazard Quotients			
	1 – 9	10 – 99	100 – 999	>1,000
B6	Arsenic (2) vegetation Arsenic (2) cottontail Barium (3) shrew Lead (1) vegetation Lead (9) shrew Zinc (2) vegetation	Aluminum (36) woodcock Arsenic (13) shrew Lead (94) woodcock Zinc (11) woodcock	Aluminum (565) vegetation Aluminum (192) cottontail	Aluminum (1,600) shrew
PO	None	Aroclor-1254 (31) cottontail	Aroclor-1254 (594) woodcock	Aroclor-1248 (1,510) cottontail Aroclor-1248 (4,390) shrew Aroclor-1254 (1,010) shrew
PS	Arsenic (2) vegetation Arsenic (2) cottontail Barium (1) cottontail Barium (6) shrew Barium (1) woodcock Cadmium (2) vegetation Cadmium (6) shrew Cadmium (7) woodcock Chromium (9) woodcock Lead (3) vegetation Zinc (9) vegetation Zinc (2) earthworm Zinc (3) shrew	Aluminum (39) woodcock Arsenic (12) shrew Chromium (45) vegetation Lead (22) shrew Zinc (44) woodcock	Aluminum (615) vegetation Aluminum (208) cottontail Chromium (112) earthworm Lead (238) woodcock	Aluminum (1,740) shrew
BK	Lead (3) shrew Chromium (7) woodcock Zinc (3) woodcock	Chromium (35) vegetation Chromium (88) earthworm Lead (29) woodcock	None	None

The distribution of surface soil COPECs by study area is summarized as follows:

- ***Aluminum***—Study Areas 2, 3, 4, 8, 16, 17, 20, 25, B6, PS
- ***Arsenic***—Study Areas 2, 3, 8, 10E, 16, 17, 18, 20, 25, B6, PS
- ***Barium***—Study Areas 2, 3, 4, 8, 10E, 16, 17, 20, 22, B6, PS
- ***Cadmium***—Study Areas 16, 22, PS
- ***Chromium***—Study Areas 2, 18, 19, 20, 22, 25, PS
- ***Cobalt***—Study Areas 3, 8, 16
- ***Copper***—Study Areas 3, 8, 16, 22
- ***Lead***—Study Areas 2, 3, 4, 6, 7, 8, 10E, 10W, 16, 18, 19, 22, 25, B6, PS
- ***Manganese***—Study Areas 2, 8, 10E, 17, 18
- ***Mercury***—Study Areas 2, 16, 22
- ***Molybdenum***—Study Area 8
- ***Nickel***—Study Areas 8, 16, 22
- ***Vanadium***—Study Areas 2, 3, 8, 16, 18, 25
- ***Zinc***—Study Areas 2, 4, 8, 16, 19, 22, 25, B6, PS
- ***Acenaphthene***—Study Area 2
- ***Aroclor-1248***—Study Area PO
- ***Aroclor-1254***—Study Area PO
- ***Benzo(a)pyrene***—Study Area 2
- ***Benzoic acid***—Study Areas 10E, 25
- ***Pyrene***—Study Area 2
- ***TNT***—Study Areas 6, 7.

Ecological risk from aluminum, arsenic, barium, lead, and zinc is fairly ubiquitous, occurring in more than half of the study areas investigated. Risk from organic compounds occurs only in Study Areas 2 and PO, and risk from explosives is confined to Study Areas 6 and 7. Risk from molybdenum is also limited to a single study area (8).

Risk was evaluated for five ecological receptors in each study area: vegetation, earthworms, cottontail, shrew, and woodcock. The SERA indicated there was risk to each of these receptors in at least one study area at ALAAP. The COPECs associated with each of these receptors are listed as follows:

- ***Vegetation***—all 14 metals, acenaphthene, pyrene

- ***Earthworms***—cadmium, chromium, copper, lead, nickel, zinc, pyrene

- ***Cottontails***—aluminum, arsenic, barium, cadmium, cobalt, copper, lead, manganese, nickel, vanadium, zinc, benzo(a)pyrene

- ***Shrews***—aluminum, arsenic, barium, cadmium, cobalt, copper, lead, manganese, molybdenum, nickel, vanadium, zinc, benzo(a)pyrene, benzoic acid, TNT

- ***Woodcocks***—aluminum, barium, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, vanadium, zinc.

Most surface soil COPECs are fairly well distributed among the ecological receptors (i.e., cadmium, copper, lead, nickel, zinc each have an HQ >1 for all five receptors and aluminum, barium, and vanadium pose risk to four out of five receptors). The organic COPECs have HQs >1 for only one or two receptors (i.e., there is risk to vegetation from acenaphthene and to shrews from benzoic acid and TNT). Benzo(a)pyrene causes risk in both cottontails and shrews. Pyrene causes risk in both vegetation and earthworms.

Further examination of Table 7-16 from a receptor perspective indicates that the highest risk (highest HQ) to ecological receptors is due to only a few COPECs in a few receptors, namely aluminum (vegetation, cottontail, and shrew) and lead (woodcock). Cobalt (shrew), nickel (vegetation), cadmium (shrew and woodcock), and chromium (vegetation and earthworm) also show HQs >100. HQs >1,000 are entirely due to aluminum in shrews and lead in woodcocks. Aluminum with HQ >1,000 occurs in Study Areas 2, 3, 4, 16, 17, 20, 25, B6, and PS. Lead with HQs >1,000 is found in Study Areas 4, 16, and 22.

HIs, or the sum of HQs for each of the five receptors in each study area, were calculated **(Table 7-22)**. Evaluation of the HIs indicates that overall, the risk HI is lowest to earthworms and cottontails, and greatest to shrews and woodcocks.

Vegetation HIs are highest (HI >500) in Study Areas 2, 3, 4, 8, 16, 17, 20, 25, B6, and PS, and are <1 in Study Areas 6 and 7. Earthworm HIs are relatively high (>100) in Study Areas 2, 18, 19, 20, 22, 25, and PS, and are <1 in Study Areas 6, 7, 10E, 10W, and PO. HIs for the cottontail are highest (>100) in Study Areas 2, 3, 4, 8, 16, 17, 20, 25, B6, PO, and PS, and are <1 in Study Areas 6, 7, and 19. HIs >1,000 for the shrew occurred in Study Areas 2, 3, 4, 8, 16, 17, 20, 25, B6, PO, and PS. There is risk to shrews from at least one COPEC in every study area examined (all HIs for this exposure group were >1). The woodcock HIs were >1,000 in Study Areas 4, 16, and 22. The primary COPECs contributing to risk (i.e., COPECs with HQs >100) in vegetation are aluminum and chromium. Aroclor-1248 poses the greatest risk to cottontails and shrews, and chromium contributes the greatest risk to earthworms. Lead is the greatest contributor of risk to the woodcock.

The SERA indicates that the greatest risk (i.e., HQs > 2,000) to surface soil ecological receptors occurs in Study Areas 4, 16, and PO. Aluminum and lead are the greatest contributors to risk in Study Areas 4 and 16, lead is the dominant COPEC in Study Area 22, and Aroclor-1248 is the dominant COPEC at PO.

Table 7-22. Hazard Indices by Receptor for Surface Soil Study Areas for ALAAP – Screen
Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area	Ecological Receptor				
	Vegetation	Earthworm	Cottontail	Shrew	Woodcock
2	663	248	184	1,550	363
3	635	3	212	1,930	499
4	602	5	194	1,830	2,640
6	<1	<1	<1	3	16
7	<1	<1	<1	6	33
8	785	62	137	1,310	659
10E	11	<1	5	26	55
10W	9	<1	1	61	667
16	655	40	185	2,040	3,140
17	591	1	204	1,680	39
18	127	203	10	79	52
19	109	268	<1	8	115
20	518	167	155	1,290	43
22	277	288	15	479	4,410
25	644	142	191	1,600	148
B6	573	2	195	1,630	141
PO	<1	<1	1,540	5,400	594
PS	678	115	213	1,790	339
BK	37	88	<1	4	40

7.6.2.2 Screening Level Ecological Risks Associated with ALAAP Sediment

Eight study areas and one BK contained sediment and were chosen for the investigation of sediment risk at ALAAP. Background is discussed separately in Section 7.7.5. There are ecological risks to sediment dwelling biota at six of the eight study areas investigated with the SERA (Appendix Tables O-265 through O-275). **Table 7-23** provides a summary of the SERA for sediment. HQs >1 were not identified for any chemical in Study Areas 5 and 16.

A total of 14 ecological COPECs were identified. These COPECs and their HQ ranges include the following:

- ***Arsenic***—HQ = 1 to 27
- ***Chromium***—HQ = 1 to 8
- ***Copper***—HQ = 1 to 33
- ***Lead***—HQ = 1 to 4
- ***Manganese***—HQ = 2 to 6

Table 7-23. Summary of Sediment Ecological COPECs (HQ >1) for Sediment-Dwelling Biota at ALAAP – Screen
Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area	Range of Hazard Quotients			
	1 – 9	10 – 99	100 – 999	>1,000
5	None	None	None	None
9	Chromium (8) Lead (4) Manganese (4) Nickel (8) Zinc (4) Benzo(g,h,i)perylene (1) Benzo(k)fluoranthene (1) Chrysene (6) Ideno(1,2,3-cd)pyrene (1)	Arsenic (27) Copper (33)	None	None
16	None	None	None	None
21	Arsenic (4) Chromium (2) Copper (2) Lead (1) Manganese (6) Mercury (1) Nickel (1) Acetone (6) Pyrene (1)	None	None	None
26	Arsenic (6) Chromium (1) Copper (1) Lead (1) Manganese (3) Acetone (4) Benzo(k)fluoranthene (1)	None	None	None
27	Arsenic (2) Chromium (2) Lead (2) Manganese (4) Mercury (2) Zinc (5)	None	None	None
CO	Copper (3) Lead (1) Mercury (6)	None	None	None
TA	Arsenic (2) Lead (4) Manganese (4)	None	None	None
BK	Arsenic (1) Copper (2) Lead (1) Manganese (2) Nickel (1) Zinc (1) Acetone (3) Pyrene (1)	None	None	None

- ***Mercury***—HQ = 1 to 6
- ***Nickel***—HQ = 1 to 8
- ***Zinc***—HQ = 1 to 5
- ***Acetone***—HQ = 4 to 6
- ***Benzo(g,h,i)perylene***—HQ = 1
- ***Benzo(k)fluoranthene***—HQ = 1
- ***Chrysene***—HQ = 6
- ***Ideno(1,2,3-cd)pyrene***—HQ = 1
- ***Pyrene***—HQ = 1.

Arsenic and copper are the only COPECs with HQ >10, as shown in Table 7-23. Lead is the most pervasive of the COPECs identified during the SERA, with HQ >1 in all six of the study areas that showed ecological risk. Risk from manganese also was widespread, with HQ >1 occurring in five study areas.

The distribution of COPECs by study area is summarized as follows:

- ***Arsenic***—Study Areas 9, 21, 26, 27, TA
- ***Chromium***—Study Areas 9, 21, 26, 27
- ***Copper***—Study Areas 9, 21, 26, CO
- ***Lead***—Study Areas 9, 21, 26, 27, TA, CO
- ***Manganese***—Study Areas 9, 21, 26, 27, TA
- ***Mercury***—Study Areas 21, 27, CO
- ***Nickel***—Study Areas 9, 21
- ***Zinc***—Study Areas 9, 27
- ***Acetone***—Study Areas 21, 26
- ***Benzo(g,h,i)perylene***—Study Area 9
- ***Benzo(k)fluoranthene***—Study Areas 9, 26
- ***Chrysene***—Study Area 9
- ***Ideno(1,2,3-cd)pyrene***—Study Area 9
- ***Pyrene***—Study Area 21.

In addition, cobalt is a COPEC for Study Area 27 and the Coosa River (Study Area CO) because there is no TRV for cobalt.

The study areas with the most COPECs (HQ >1 calculated for sediment dwelling biota) are Study Areas 9 (11 COPECs), 21 (9 COPECs), 26 (7 COPECs), and 27 (7 COPECs) (Table 7-23).

The HI, defined as the sum of HQs for each study area, is as follows:

- ***Study Area 5***—HI = 0
- ***Study Area 9***—HI = 97

- ***Study Area 16***—HI = 0
- ***Study Area 21***—HI = 30
- ***Study Area 26***—HI = 21
- ***Study Area 27***—HI = 18
- ***Study Area CO***—HI = 11
- ***Study Area TA***—HI = 11
- ***BK***—HI = 14.

The SERA indicates that the greatest risk (as defined by HI) to sediment dwelling biota occurs in Study Area 9.

7.6.2.3 Screening Level Ecological Risks Associated with ALAAP Surface Water

A total of seven surface water study areas and one background area were identified at ALAAP. Background is discussed in Section 7.7.5. There are ecological risks to aquatic biota and mink at six of the seven study areas investigated in the SERA (Appendix Tables O-294 through O-317 in Appendix O). There were no identifiable risks to the great blue heron. **Table 7-24** provides a summary of the SERA for aquatic biota and mink. HQs >1 were not identified for any chemical in any receptor at Talladega Creek (Study Area TA).

A total of eight inorganic COPECs, one organic COPEC, and two explosive COPECs were identified for surface water receptors in the SERA (Table 7-24). These COPECs and the range of HQs include the following:

- ***Aluminum***—HQ = 1 to 25
- ***Arsenic***—HQ = 2 to 3
- ***Barium***—HQ = 15 to 17
- ***Cobalt***—HQ = 47 to 59
- ***Copper***—HQ = 1
- ***Iron***—HQ = 2 to 11
- ***Lead***—HQ = 1 to 2
- ***Manganese***—HQ = 1 to 53
- ***Carbon disulfide***—HQ = 3
- ***2,4-DNT***—HQ = 3 to 5
- ***TNT***—HQ = 6 to 24.

The COPECs identified during the SERA have HQs between 1 and 59. Iron is the most widespread COPEC for aquatic biota, occurring in five study areas. Aluminum and manganese also are pervasive, occurring as surface water COPECs in two receptors and in four study areas.

Table 7-24. Summary of Surface Water COPECs (HQ >1) for ALAAP – Screen Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area	Range of Hazard Quotients			
	1 – 9	10 – 99	100 – 999	>1,000
9	Copper (1) aquatic biota Iron (2) aquatic biota Lead (1) aquatic biota	None	None	None
16	2,4-DNT (5) mink TNT (6) mink	Cobalt (47) aquatic biota Cobalt (59) mink Iron (11) aquatic biota Manganese (10) aquatic biota	None	None
21	Aluminum (2) mink Arsenic (3) mink Iron (5) aquatic biota Lead (2) aquatic biota Manganese (1) mink Carbon disulfide (3) aquatic biota	Aluminum (25) aquatic biota Barium (17) aquatic biota Manganese (15) aquatic biota	None	None
26	Aluminum (1) mink Arsenic (2) mink Iron (5) aquatic biota Manganese (2) mink Carbon disulfide (3) aquatic biota	Aluminum (15) aquatic biota Barium (17) aquatic biota Manganese (29) aquatic biota	None	None
27	Iron (6) aquatic biota Lead (2) aquatic biota 2,4-DNT (3) mink Manganese (4) mink	Aluminum (14) aquatic biota Barium (15) aquatic biota Manganese (53) aquatic biota TNT (24) mink	None	None
CO	Aluminum (6) aquatic biota	None	None	None
TA	None	None	None	None
BK	Aluminum (4) aquatic biota Manganese (2) aquatic biota	None	None	None

The distribution of surface water COPECs by study area is summarized as follows:

- ***Aluminum***—Study Areas 21, 26, 27, CO
- ***Arsenic***—Study Areas 21, 26
- ***Barium***—Study Areas 21, 26, 27
- ***Cobalt***—Study Area 16
- ***Copper***—Study Area 9
- ***Iron***—Study Areas 9, 16, 21, 26, 27
- ***Lead***—Study Areas 9, 21, 27
- ***Manganese***—Study Areas 16, 21, 26, 27
- ***Carbon disulfide***—Study Areas 21, 26
- ***2,4-DNT***—Study Areas 16, 27
- ***TNT***—Study Areas 16, 27.

Study Areas 21, 26, and 27 contain the greatest diversity of COPECs (between 6 and 7 each). The Coosa River (Study Area CO) has only one COPEC identified (aluminum).

Risk was evaluated for three distinct receptors in each study area: aquatic biota, mink, and great blue heron. There was no identifiable risk to the great blue heron in the SERA at any of the study areas. The COPECs associated with the other two receptors, and the HQ range, are summarized in the following:

- ***Aquatic Biota***—Aluminum, barium, cobalt, copper, iron, lead, manganese, and carbon disulfide

- ***Mink***—Aluminum, arsenic, cobalt, manganese, 2,4-DNT, and TNT.

With the exception of cobalt and TNT, all HQs >10 are for the aquatic biota receptor.

The HIs, or sums of HQs for each receptor in each study area, are listed in **Table 7-25**.

Table 7-25. Hazard Indices for Ecological Receptors in Surface Water for ALAAP – Screen Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area	Ecological Receptor		
	Aquatic Biota	Mink	Great Blue Heron
9	4	<1	<1
16	68	71	<1
21	69	6	<1
26	70	5	<1
27	90	33	<1
CO	6	<1	<1
TA	<1	<1	<1
BK	6	<1	<1

The SERA indicates that the areas with the highest risk to ecological receptors are Study Areas 16, 21, 26, and 27. Risk at Study Area 16 is due in large part to cobalt in mink (HQ = 59) and in aquatic biota (HQ = 47). Aluminum, barium, and manganese in aquatic biota (HQs of 15, 17, and 29, respectively) contribute to risk in Study Area 26. Risk at Study Area 27 is due primarily to manganese in aquatic biota (HQ = 53) and TNT in mink (HQ = 24). The remaining COPECs have HQs between 1 and 25 (Table 7-24).

7.6.2.4 Screening Level Risks for Aggregated Study Areas

The risk quotients for deer, red fox, and hawks exposed to soil COPECs over multiple ALAAP study areas and background are shown in Appendix Tables O-123 to O-133. All three receptors exhibit risk in excess of HQs >1. The COPECs are usually aluminum and a few metals, e.g., cobalt, vanadium, and zinc. The HIs also exceed 1 for each receptor at each aggregated study area. They range from 6 for deer at aggregated Study Area 7/8/10/25/PO/PS and hawk at aggregated Study Area 6/7/8/10/17/18/20/25/PO to 50 for foxes at aggregated Study Area 16/17/19/22.

The results of the SERA indicate that HIs for the three aggregated study areas for the red fox are >10, driven mostly by aluminum. HIs for the other receptor aggregates are all <10, with aluminum the driving COC for the white tailed deer, and zinc posing risk to the red-tailed hawk.

7.6.2.5 Previous Remediation

Extensive soil moving, remedial activities, and backfilling with clean soil have been performed at Study Areas 6, 7, 10, 16, 19, and 21. Post-remedial soil sampling has occurred at the level of a few hundred samples for concentrations of explosives and lead. These data show that the concentrations of explosives are too low to pose ecological risks to any of the receptors. With one exception, this also was the preliminary finding for lead. There may be one sampling location with sufficiently high concentrations of lead to cause risk to woodcocks along the soil-earthworm-woodcock pathway. In addition, remedial actions have taken place at Study Areas 9, 22, and PO.

7.6.3 Future Ecological Risks Associated with the SERA

Future estimated risks to the plants and animals at the exposure unit can be considered to be similar to current risks. It is assumed that the same species of plants and animals will continue to be present at ALAAP over the next decades. Habitats may change as a result of ecological succession and land use changes. This may affect the exact set of receptors at some locations that currently are in old fields and could succeed to forests. In the context of this work, such changes are believed to be subtle, and no computations were made for future conditions only. Again, future and current baseline risks are assumed to be similar. Therefore, the HQs shown and discussed previously for current conditions are assumed also to be for future conditions.

7.7 BASELINE ECOLOGICAL RISK ASSESSMENT

Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (EPA 1997a) outlines an eight-step process for documenting actual or potential ecological impacts at an exposure unit; identifying the constituents at an exposure unit posing a potential risk; and generating data to be used in evaluating cleanup options. The SERA entails Steps 1 and 2 of that process.

EPA guidance (EPA 1997a) provides procedures for designing and conducting technically defensible ERAs for the Superfund Program. Although the guidance provides a technically valid approach, it does not dictate the scale, complexity, protocols, data needs, or investigation methods. Professional judgment is required to design and conduct ERAs. To assure consensus on the design and conduct of the assessment, scientific/management decision points (SMDPs) occur at several steps along the process. At SMDPs, risk managers and risk assessors evaluate and approve or redirect the assessment. For example, during the SMDP following the screening-level assessment (Steps 1 and 2), it must be decided if a baseline or more full ERA (Steps 3 through 7) is needed. Another SMDP occurs following the exposure unit Investigation and Analysis of Exposure and Effects (Step 6), when the need for additional investigation or analysis is evaluated.

The eight-step BERA (EPA 1997a) process used at ALAAP is described as "not a simple linear or sequential process." The process can be iterative if it is decided at SMDPs that additional investigation or analysis is required. Therefore, some steps may be repeated and others omitted in subsequent iterations of the process. For instance, the screening-level assessment (Steps 1 and 2) might be performed only once. Subsequent steps (Steps 3 to 7), corresponding to the baseline ecological risk assessment might be repeated several times with each iteration building on information already developed for the exposure unit, thereby reducing the uncertainty associated with the assessment.

7.7.1 More Information about the 1997 Guidance

The first two steps of the BERA process are the Screening Level Problem Formulation and Ecological Effects Evaluation (Step 1) and the Screening Level Exposure Estimate and Risk Characterization (Step 2). Together, Steps 1 and 2 constitute a SERA. SERAs are simplified risk assessments that can be conducted with limited data by assuming values for parameters for which data are lacking. Assumptions for exposure and toxicity values are biased toward overestimating risk in a screening-level assessment. Conservative assumptions are used to ensure that study areas are not dismissed from further evaluation during a baseline or full ERA when unacceptable risk actually exists at the exposure unit. If results of the screening assessment indicate that additional evaluation is necessary, the ERA process continues with Step 3.

The BERA comprises five steps of the eight-step process: Problem Formulation (Step 3), Study Design and DQO Process (Step 4), Verification of Field Sampling Design (Step 5), exposure unit Investigation and Data Analysis (Step 6), and Risk Characterization (Step 7). The eighth step, Risk Management, entails a management decision on whether to clean up an exposure unit and, if so, to what level the contamination will be cleaned up.

Each of the five steps of the BERA for the ALAAP study areas is discussed in this report. The Problem Formulation (Step 3), the data analysis portion of the exposure unit Investigation and Data Analysis (Step 6), and the Risk Characterization (Step 7) are presented as part of the ERA. These steps correspond to the three phases presented in *The Framework for Ecological Risk Assessment* (EPA 1992a), on which the presentation of the 1997 Guidance ERA is modeled. Steps

4 and 5 and the exposure unit investigation portion of Step 6 are presented elsewhere in this RI report for the study areas. These include nature and extent evaluation and human health risk assessment. Other components of the RI include similar steps.

7.7.2 Revised Step 6 in BERA

The analysis phase of the ERA (Step 6) consists of technical evaluation of exposure and effects information collected during Steps 1 to 5 and additional assumptions or models for interpreting data in the conceptual exposure unit model context (EPA 1997a). In Step 6, exposure unit-specific data obtained during the exposure unit investigation replaces many assumptions that were made for the screening-level ERA. Uncertainties associated with field measurements and with assumptions or published values where exposure unit-specific data are not available must be documented. The BERA incorporates information about the variability of field measurements, exposure information, and toxicity information to reduce the uncertainty of risk calculations.

The following sections discuss exposure and effects parameters or variables.

7.7.2.1 Exposure

Exposure Point Concentration—The maximum detected COPEC concentration in the environment is typically used as the exposure point concentration in screening-level assessments. The 1997 ERA Guidance recommends the lower of the maximum detected concentration or UCL_{95} as the exposure point concentration. The exposure analysis (Step 6) results in an exposure profile that quantifies the magnitude and variability of exposure (EPA 1997a). Step 6 of the BERA as reported in this RI uses the RME (Round 1) and the arithmetic mean (Round 2). The arithmetic mean concentration is a more realistic estimate of the central tendency exposure to members of the receptor population. Arithmetic mean values are provided in tables dealing with BERAs.

Area-use Factor—The assumption that the home ranges of all terrestrial receptor species are entirely within the contaminated area (AUF = 1), and thus, that animals obtain 100 percent of their food, water, and incidentally ingested soil from the exposure area, is a conservative one for some species. The assumption is that AUF = 1 is applicable to screening-level assessments (EPA 1997a). Species- and exposure unit-specific home range information is needed in the data analysis phase of the BERA (Step 6) to estimate more accurately the percentage of the receptor's exposure from the affected area. Published species-specific values for home range or foraging area (EPA 1993f) as shown in the receptor profiles are used in Step 6 of the BERA. Home ranges are values selected from the literature (e.g., EPA 1993f) based on professional judgment. The selected values are judged to be most appropriate for the site based on an understanding of the ecological characteristics at ALAAP. See Tables 7-18 through 7-20.

Bioavailability—The assumption that the bioavailability of substances at the ALAAP study areas is equal to that of the media used in experiments for setting screening benchmark values is relaxed in the BERA. Ideally, exposure unit-specific or published information about the

bioavailability of substances in environmental media are used to estimate exposure by ingestion of contaminated matter for the ALAAP ERA. These values are the same for both screening and BERAs.

Body Weight—Published body weights for receptors are used to estimate exposure by ingestion of contaminated matter. Published body weights used in the BERA are those presented in EPA (1993f) and other sources as shown on the receptor profiles (Appendix Tables O-144 and O-146). These published body weights are used beginning with Appendix Table O-149.

Ingestion Rate—Published ingestion rates for receptors are used to estimate exposure by ingestion of contaminated matter. Published ingestion rates used in the BERA are those in EPA (1993f) and other sources.

Bioaccumulation Factor—Published bioaccumulation factors are used in the BERA. Bioaccumulation factors are published in HAZWRAP (1994) and other sources (as shown in Appendix Tables O-31 and O-32) are used to estimate exposures by ingestion of biota.

Diets—Published diets for receptors are used to estimate exposure by ingestion of potentially contaminated matter. Published diets used in the BERA are those in EPA (1993f), provided in receptor profiles (Tables 7-5 through 7-10, 7-13, and 7-14), and other sources.

In summary, exposure parameters that differ in the SERA and the BERA are the exposure point concentration and the area use factor.

7.7.2.2 Effects

The following paragraphs discuss exposure parameters or variables.

Body Weight Conversion—The BERA requires replacing generic data with species- or exposure unit-specific data wherever possible. The effects thresholds for screening and BERAs used effects thresholds for laboratory test animals. Species-specific effects thresholds are used in the effects evaluation (Step 6). Species-specific effects thresholds are derived from published effects thresholds for laboratory test species by scaling the threshold dose to body weight (Sample et al. 1996). For both mammals and birds, the corresponding tests species LOAEL for a mammal or bird test species is multiplied by the body weight ratio of the test species and the receptor species, raised to the 0.25 power (Opresko et al. 1995). This body-weight conversion is consistent and is supported by data (Chappell 1992, Travis and White 1988). The conversion is used to scale rat toxicity data for carcinogens to humans (EPA 1992a). This information is provided in Appendix Tables O-144 (mammals) and O-145 (birds) for LOAELs.

Effects Measurements—Two toxic effects measurements are typically used for terrestrial organisms: NOAEL and LOAEL. The NOAEL is the more conservative one and is used in the SERA. The LOAEL is used only in the BERA (see Appendix Tables O-142 and O-143). Water

toxicity and sediment toxicity, if needed in a BERA, are the same measurements—AWQC and ER-L—as used in the SERA (Appendix Tables O-265 and O-293).

7.7.2.3 Summary of Baseline Risk Approach

The exposure part of the baseline risk work uses an arithmetic mean (versus the RME in the SERA) and a more realistic AUF. The effects part uses a LOAEL or equivalent (versus the NOAEL or equivalent) in the screening. Thus, the BERA uses less conservative exposure and less conservative effects information, compared to the SERA.

7.7.3 Current Ecological Risks Associated with the BERA

Current baseline risk to ecological receptors exposed to ALAAP media are presented in this section. The summary tables for soil, sediment and surface water are based on the many tables in Appendix O.

7.7.3.1 Baseline Ecological Risk Assessment Associated with ALAAP Surface Soils

Based on the SERA results (Section 7.6.2), a BERA was performed on the same ecological receptors in the 18 study areas and background site (Tables O-147 to O-252 in Appendix O). Background is discussed separately in Section 7.7.5. **Table 7-26** provides a summary of the BERA. HQs >1 were identified for at least one ecological receptor in every study area except Study Area 19. There were no HQs >1,000 for any COC in any of the study areas.

Sixteen of the 21 COPECs identified during the SERA were identified as COCs in the BERA. The organic compounds and explosives identified during the SERA were found also to contribute risk at HQs <1. Only two organic COCs, Aroclor-1248 and Aroclor-1254, were identified.

The COCs identified during the BERA, and their range of HQs, are as follows:

- ***Aluminum***—HQ = 1 to 488
- ***Arsenic***—HQ = 1 to 5
- ***Barium***—HQ = 1 to 5
- ***Cadmium***—HQ = 1 to 64
- ***Chromium***—HQ = 26 to 114
- ***Cobalt***—HQ = 1
- ***Copper***—HQ = 2 to 16
- ***Lead***—HQ = 1 to 78
- ***Manganese***—HQ = 2 to 4
- ***Mercury***—HQ = 2 to 5

Table 7-26. Summary of Surface Soil COCs (HQ >1) for ALAAP – Baseline Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area	Range of Hazard Quotients			
	1 – 9	10 – 99	100 – 999	>1,000
2	Aluminum (3) woodcock Arsenic (2) vegetation Barium (4) woodcock Lead (1) vegetation Manganese (2) vegetation Vanadium (2) shrew Zinc (2) vegetation	Aluminum (34) cottontail Aluminum (96) shrew Chromium (36) vegetation Lead (11) woodcock Vanadium (27) vegetation	Aluminum (391) vegetation	None
3	Arsenic (4) vegetation Arsenic (1) cottontail Arsenic (2) shrew Cobalt (1) vegetation Lead (4) vegetation Lead (1) shrew Lead (3) woodcock Vanadium (2) shrew	Vanadium (34) vegetation	None	None
4	Lead (3) shrew Lead (3) woodcock Zinc (2) vegetation	Aluminum (16) cottontail Lead (10) vegetation	Aluminum (434) vegetation Aluminum (107) shrew	None
6	Lead (2) woodcock	None	None	None
7	Lead (2) woodcock	None	None	None
8	Aluminum (2) woodcock Arsenic (2) vegetation Barium (4) woodcock Lead (3) vegetation Manganese (3) vegetation Molybdenum (3) vegetation Nickel (5) earthworm Nickel (1) shrew Nickel (2) woodcock Vanadium (2) shrew Zinc (2) vegetation	Aluminum (27) cottontail Aluminum (77) shrew Lead (21) woodcock Nickel (34) vegetation Vanadium (32) vegetation	Aluminum (313) vegetation	None
10E	Barium (2) woodcock Lead (3) woodcock Manganese (4) vegetation	None	None	None
10W	Lead (5) vegetation Lead (2) shrew	Lead (31) woodcock	None	None
16	Arsenic (3) vegetation Arsenic (1) shrew Barium (1) woodcock Cadmium (2) earthworm Cadmium (8) shrew Cadmium (2) woodcock Copper (8) vegetation Copper (2) cottontail	Aluminum (27) cottontail Aluminum (77) shrew Cadmium (64) vegetation Copper (16) earthworm Lead (54) vegetation Lead (17) shrew Lead (78) woodcock Vanadium (25) vegetation	Aluminum (316) vegetation	None

Table 7-26. Summary of Surface Soil COCs (HQ >1) for ALAAP – Baseline Alabama Army Ammunition Plant, Childersburg, Alabama (Continued)

Study Area	Range of Hazard Quotients			
	1 – 9	10 – 99	100 – 999	>1,000
16 (cont'd.)	Copper (3) shrew Lead (5) earthworm Mercury (5) vegetation Nickel (1) vegetation Vanadium (2) shrew Zinc (3) vegetation	None	None	None
17	Aluminum (3) woodcock Arsenic (5) vegetation Arsenic (1) cottontail Arsenic (2) shrew Barium (5) woodcock Manganese (3) vegetation	Aluminum (35) cottontail	Aluminum (410) vegetation Aluminum (101) shrew	None
18	Arsenic (1) vegetation Manganese (2) vegetation Vanadium (1) shrew	Chromium (32) vegetation Chromium (79) earthworm Vanadium (23) vegetation	None	None
19	None	None	None	None
20	Aluminum (1) woodcock Arsenic (1) vegetation Barium (1) woodcock	Aluminum (30) cottontail Aluminum (87) shrew Chromium (40) vegetation	Aluminum (352) vegetation Chromium (100) earthworm	None
22	Lead (3) earthworm Lead (8) shrew Lead (4) woodcock Mercury (2) vegetation Nickel (2) vegetation Zinc (3) shrew	Lead (26) vegetation Zinc (11) earthworm	None	None
25	Arsenic (2) vegetation Vanadium (2) shrew Zinc (3) vegetation	Chromium (45) vegetation Vanadium (28) vegetation	Chromium (114) earthworm	None
B6	Aluminum (1) cottontail Arsenic (2) vegetation Lead (1) vegetation Zinc (2) vegetation	Aluminum (25) shrew	Aluminum (512) vegetation	None
PO	Aroclor-1248 (3) shrew Aroclor-1254 (4) shrew	None	None	None
PS	Aluminum (2) cottontail Arsenic (1) vegetation Cadmium (1) vegetation Lead (2) vegetation Zinc (5) vegetation Zinc (1) earthworm	Aluminum (47) shrew Chromium (26) vegetation Chromium (65) earthworm	Aluminum (488) vegetation	None
BK	Lead (3) woodcock	Chromium (27) vegetation Chromium (67) earthworm	None	None

- ***Molybdenum***—HQ = 3
- ***Nickel***—HQ = 1 to 34
- ***Vanadium***—HQ = 1 to 34
- ***Zinc***—HQ = 1 to 5
- ***Aroclor-1248***—HQ = 3
- ***Aroclor-1254***—HQ = 4.

Not only are there fewer COCs (compared to COPECs in the SERA), but the range of HQs is much smaller.

The distribution of COCs by study area is shown as follows:

- ***Aluminum***—Study Areas 2, 4, 8, 16, 17, 20, B6, PS
- ***Arsenic***—Study Areas 2, 3, 8, 16, 17, 18, 20, 25, B6, PS
- ***Barium***—Study Areas 2, 8, 10E, 16, 17, 20
- ***Cadmium***—Study Areas 16, PS
- ***Chromium***—Study Areas 2, 18, 20, 25, PS
- ***Cobalt***—Study Area 3
- ***Copper***—Study Area 16
- ***Lead***—Study Areas 2, 3, 4, 6, 7, 8, 10E, 10W, 16, 22, B6, PS
- ***Manganese***—Study Areas 2, 8, 10E, 17, 18
- ***Mercury***—Study Areas 16, 22
- ***Molybdenum***—Study Area 8
- ***Nickel***—Study Areas 8, 16, 22
- ***Vanadium***—Study Areas 2, 3, 8, 16, 18, 25
- ***Zinc***—Study Areas 2, 4, 8, 16, 22, 25, B6, PS
- ***Aroclor-1248***—Study Area PO
- ***Aroclor-1254***—Study Area PO.

Lead, arsenic, and aluminum are the most widespread contributors to ecological risk, with HQs >1 for at least one ecological receptor in more than half of the study areas investigated. Study Area 16 has the greatest diversity of COCs, with 10 different chemicals identified with HQs >1. Study Area 8 has nine COCs, and Study Area 2 has eight COCs posing risk to at least one ecological receptor.

The ecological receptors evaluated to determine risk associated with surface soils at ALAAP included terrestrial vegetation, earthworms, cottontails, shrews, and woodcocks. The COCs associated with each of the ecological receptors are as follows:

- ***Vegetation***—aluminum, arsenic, cadmium, chromium, cobalt, lead, manganese, molybdenum, nickel, vanadium, zinc

- ***Earthworm***—cadmium, chromium, copper, lead, nickel, zinc
- ***Cottontail***—aluminum, arsenic, copper
- ***Shrew***—aluminum, Aroclor-1248, Aroclor-1254, arsenic, cadmium, copper, lead, nickel, vanadium, zinc
- ***Woodcock***—aluminum, barium, cadmium, lead, nickel.

In each of these receptors, at least one COC was found to cause risk in surface soil in at least one of the ALAAP surface soil study areas.

To compare cumulative risk among different receptors in different study areas, HIs were calculated. The HI for each ecological receptor in each study area is presented in **Table 7-27**. Evaluation of the HIs indicates that risk (as defined by HI) is highest (HI >100) for vegetation in Study Areas 2, 4, 8, 16, 17, 20, B6, and PS, but there is no risk to vegetation in Study Areas 6, 7, and PO. There is higher risk (HI >100) to earthworms in Study Areas 20 and 25, and no risk to this receptor in Study Areas 6, 7, 10E, 10W, 19, and PO. Risk to the cottontail is <100 in all study areas, and <1 in Study Areas 6, 7, 10E, 10W, 18, 19, 22, 25, and PO. Risk to the shrew is highest (HI >100) in Study Areas 2, 4, and 16, and Study Areas 6, 7, and 19 show no risk to this receptor. Risk to the woodcock is relatively low, with all HIs <100, and HIs <1 in Study Areas 18, 19, 25, B6, PO, and PS.

Table 7-27. Hazard Indices by Receptor for Surface Soil Study Areas – Baseline Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area	Ecological Receptor				
	Vegetation	Earthworm	Cottontail	Shrew	Woodcock
2	463	92	35	100	19
3	44	2	2	6	5
4	447	2	16	110	3
6	<1	<1	<1	<1	2
7	<1	<1	<1	<1	2
8	393	7	29	84	30
10E	6	<1	<1	1	6
10W	5	<1	<1	2	31
16	481	25	31	109	82
17	419	1	37	104	8
18	58	79	<1	2	<1
19	2	<1	<1	<1	<1
20	394	101	31	87	3
22	73	14	<1	11	5
25	80	115	<1	3	<1
B6	518	2	1	25	<1
PO	<1	<1	<1	7	<1
PS	526	67	2	48	<1
BK	28	68	<1	<1	3

7.7.3.2 Baseline Ecological Risk Assessment Associated with ALAAP Sediment

Based on the SERA results, a BERA was performed on the eight study areas and background site, with ecological COCs identified at six of the eight areas (Tables O276 through O-284 in Appendix O). Background is discussed separately at the end of this section. The BERA is a less conservative approach, e.g., exposure of arithmetic mean and effects of the LOAEL. **Table 7-28** provides a summary of the BERA. HQs >1 were not identified for any chemical in Study Areas 5 or 16, or in the Coosa River (Study Area CO).

Table 7-28. Summary of Sediment COCs (HQ >1) for ALAAP – Baseline Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area	Range of Hazard Quotients			
	1 – 9	10 – 99	100 – 999	>1,000
5	None	None	None	None
9	Chromium (4) Lead (3) Manganese (2) Nickel (5) Zinc (2) Benzo(g,h,i)perylene (2) Benzo(k)fluoranthene (2) Chrysene (2) Ideno(1,2,3-cd)pyrene (1)	Arsenic (15) Copper (17)	None	None
16	None	None	None	None
21	Arsenic (3) Chromium (2) Copper (2) Lead (1) Manganese (4) Acetone (5) Pyrene (1)	None	None	None
26	Arsenic (5) Chromium (1) Manganese (2) Acetone (4)	None	None	None
27	Arsenic (2) Chromium (1) Lead (1) Manganese (3) Zinc (2)	None	None	None
CO	Mercury	None	None	None
TA	Arsenic (2) Lead (1) Manganese (2)	None	None	None
BK	Arsenic (1) Copper (1) Manganese (2) Acetone (3)	None	None	None

Thirteen of the 14 chemicals identified as COPECs in the SERA also were identified during the BERA. These COCs and their HQ ranges include the following:

- ***Arsenic***—HQ = 1 to 15
- ***Chromium***—HQ = 1 to 4
- ***Copper***—HQ = 1 to 17
- ***Lead***—HQ = 1 to 3
- ***Manganese***—HQ = 2 to 4
- ***Mercury***—HQ = 2
- ***Nickel***—HQ = 5
- ***Zinc***—HQ = 2
- ***Acetone***—HQ = 3 to 5
- ***Benzo(g,h,i)perylene***—HQ = 2
- ***Benzo(k)fluoranthene***—HQ = 2
- ***Chrysene***—HQ = 2
- ***Ideno(1,2,3-cd)pyrene***—HQ = 1
- ***Pyrene***—HQ = 1.

The maximum HQs for arsenic, copper, lead, nickel, and zinc are found in Study Area 9. Arsenic is the most widespread COC, with HQs >1 in five of the six study areas showing ecological risk. Manganese also was widespread, with risk in five of the six study areas and the background locations.

The distribution of COCs by study area is summarized in the following:

- ***Arsenic***—Study Areas 9, 21, 26, 27, TA
- ***Chromium***—Study Areas 21, 26, 27
- ***Copper***—Study Areas 9, 21
- ***Lead***—Study Areas 9, 21, 27, TA
- ***Manganese***—Study Areas 9, 21, 26, 27, TA
- ***Mercury***—Study Area CO
- ***Nickel***—Study Area 9
- ***Zinc***—Study Areas 9, 27
- ***Acetone***—Study Areas 21, 26
- ***Benzo(g,h,i)perylene***—Study Area 9
- ***Benzo(k)fluoranthene***—Study Area 9
- ***Chrysene***—Study Area 9
- ***Ideno(1,2,3-cd)pyrene***—Study Area 9
- ***Pyrene***—Study Area 21.

Study Areas 9, 21, and 27 have the highest number of COCs (risk of HQ >1 to sediment-dwelling biota), which is the same result as in the SERA.

The HIs for each of the study areas are as follows:

- ***Study Area 5***—HI = 0
- ***Study Area 9***—HI = 56
- ***Study Area 16***—HI = 2
- ***Study Area 21***—HI = 23
- ***Study Area 26***—HI = 18
- ***Study Area 27***—HI = 12
- ***Study Area CO***—HI = 3
- ***Study Area TA***—HI = 5
- ***Study Area BK***—HI = 11.

The results of the BERA indicate that the greatest risk (as defined by HI) to sediment-dwelling biota is at Study Areas 9, 21, 26, and 27. Study Area 9 had the highest HI in the SERA, and this has been confirmed by the results of the BERA.

7.7.3.3 Baseline Ecological Risk Assessment Associated with ALAAP Surface Water

Based on the results of the SERA, a BERA was performed on the same ecological receptors in the seven surface water study areas and background location. (Appendix Tables O-318 through O-341). Background is discussed in Section 7.7.5. The BERA is a less conservative approach than the SERA, e.g., exposure of arithmetic mean and effects of the LOAEL. **Table 7-29** provides a summary of the BERA. There was no risk identified to the mink or blue heron receptors, but HQs >1 occurred for at least one COPEC in all study areas except Talladega Creek (Study Area TA). There were no HQs >100 in any of the study areas.

Eight of the 11 COPECs identified during the SERA were identified as COCs in the BERA. These COCs and the range of HQs include the following:

- ***Aluminum***—HQ = 2 to 15
- ***Barium***—HQ = 11 to 14
- ***Cobalt***—HQ = 47
- ***Copper***—HQ = 1
- ***Iron***—HQ = 2 to 11
- ***Lead***—HQ = 1
- ***Manganese***—HQ = 1 to 11
- ***Carbon disulfide***—HQ = 1.

Table 7-29. Summary of Surface Water COCs (HQ >1) for ALAAP – Baseline Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area	Range of Hazard Quotients			
	1 – 9	10 – 99	100 – 999	>1,000
9	Copper (1) aquatic biota Iron (2) aquatic biota Lead (1) aquatic biota	None	None	None
16	None	Cobalt (47) aquatic biota Iron (11) aquatic biota Manganese (10) aquatic biota	None	None
21	Iron (3) aquatic biota Carbon disulfide (1) aquatic biota	Aluminum (15) aquatic biota Barium (14) aquatic biota Manganese (10) aquatic biota	None	None
26	Aluminum (5) aquatic biota Iron (3) aquatic biota	Barium (13) aquatic biota Manganese (10) aquatic biota	None	None
27	Aluminum (3) aquatic biota Iron (2) aquatic biota	Barium (11) aquatic biota Manganese (11) aquatic biota	None	None
CO	Aluminum (4) aquatic biota	None	None	None
TA	None	None	None	None
BK	Aluminum (2) aquatic biota Manganese (1) aquatic biota	None	None	None

Not only are there fewer COCs (compared to COPECs in the SERA), but the range of HQs is smaller. Iron is the most widespread COC, with HQs >1 in five of the six study areas showing ecological risk. Aluminum and manganese each appear at HQs >1 at four sites, confirming the results of the SERA.

The distribution of COCs by study area is summarized in the following:

- ***Aluminum***—Study Areas 21, 26, 27, CO.
- ***Barium***—Study Areas 21, 26, 27
- ***Cobalt***—Study Area 16
- ***Copper***—Study Area 9
- ***Iron***—Study Areas 9, 16, 21, 26, 27
- ***Lead***—Study Area 9
- ***Manganese***—Study Areas 16, 21, 26, 27
- ***Carbon disulfide***—Study Area 21.

Study Areas 9, 16, 21, 26, and 27 contain the greatest diversity of COCs (between three and five each). The Coosa River (Study Area CO) has only one COC identified (aluminum). No risk was found in Talladega Creek (Study Area TA).

The ecological receptors evaluated to determine risk associated with surface water at ALAAP included aquatic biota, mink, and great blue herons. No risk was identified to mink or herons. All the COCs listed previously are associated with aquatic biota.

The HIs for each receptor in each study area are presented in **Table 7-30**.

Table 7-30. Hazard Indices for Ecological Receptors in Surface Water at ALAAP – Baseline Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area	Ecological Receptor		
	Aquatic Biota	Mink	Great Blue Heron
9	4	<1	<1
16	68	<1	<1
21	43	<1	<1
26	33	<1	<1
27	29	<1	<1
CO	4	<1	<1
TA	<1	<1	<1
BK	3	<1	<1

7.7.3.4 Baseline Ecological Risks for Aggregated Study Areas

The BERA showed few HQs greater than 1 (Appendix Table O-237 through O-244). Aluminum is the principal COC with a maximum HQ of 2 for deer at Study Areas 17, 18, and PS; and for red fox at Study Areas 6, 7, 8, 10, 17, 18, 20, 25, and PO. Most HIs are 1 or less than 1, the only exception being an HI of 3 for aluminum to red fox at aggregate Study Areas 6, 7, 8, 10, 17, 18, 20, 25, and PO. There are no HQs or HIs >1 for the hawk. Thus, there is little or no ecological risk from the aggregate sites to near- or far-reaching ecological receptors.

7.7.4 Future Ecological Risks Associated with the BERA

Future estimated risks to plants and animals at the exposure unit are considered similar to current risks. It is assumed that the same species of plants and animals will continue to be present at ALAAP over the next decades. Habitats may change as a result of ecological succession and land use changes. This may affect the exact set of receptors at some locations that are currently in old fields and could succeed to forests. Such changes are believed to be subtle in the context of this work, and no computations were made solely for future conditions. Again, future and current baseline risks are assumed to be similar.

7.7.5 Background

In addition to the 18 study areas examined to determine risk to surface soil receptors, background locations were chosen for evaluation. As with the other study areas, both a SERA and BERA were performed at the background locations. The results are included in Appendix O (Tables O-134 through O-137 and O-248 through O-252), and on Tables 7-21, 7-22, 7-26, and 7-27. The SERA identified three COPECs (chromium, lead, and zinc) with HQs ranging from 3 (lead in shrew and zinc in woodcock) to 88 (chromium in earthworms) (Table 7-21). Ecological risk was identified for all receptors except the cottontail (HI <1). The HI for the vegetation, earthworm, shrew, and woodcock was within the range of low HIs calculated for these receptors at other study areas, with the possible exception of the earthworm. The screening HI for earthworms (HI = 89) was higher than the HI for this receptor at 12 of the 18 surface soil study areas (Table 7-22).

The BERA for background identified lead and chromium as COCs. Lead in the woodcock receptor has an HQ of 3, chromium in vegetation an HQ of 27, and the HQ is 67 in earthworms (Table 7-23). There was no risk to the cottontail and shrew ecological receptors at the background location. Ecological risks for vegetation and woodcock receptors were 28 and 3, respectively, and these HIs are actually higher than HIs in some study areas. The baseline HI for earthworms (68) is higher than all but three of the ALAAP surface soil study areas (Table 7-27).

In addition to the eight study areas examined to determine risk to sediment-dwelling biota, a background location was chosen for evaluation. Like the other eight study areas, both a SERA and a BERA were conducted at the background study area. The results are included in Appendix O (Tables O-275 and O-284), and in Tables 7-23 and 7-28. The SERA identified seven COPECs (arsenic, copper, lead, manganese, nickel, zinc, and pyrene) at this area, with HQs between 1 and 2. The HI for BK based on screening level assessment was 11, the lowest study area with identified risk based on the SERA.

The BERA for BK identified three COCs, with HQs of 1 (arsenic and copper) to 2 (manganese). The HI for this study area using the BERA data was 8. Of the study areas with identified risk based on BERA data, only the Coosa River (Study Area CO) had an HI of less than 8. Most of the COPECs and COCs identified in the SERA and BERA are fairly ubiquitous chemicals, in particular, arsenic and copper. These COPECs were the two identified in the SERA with HQs >10 at Study Area 9.

In addition to the seven study areas examined to determine risk to surface water receptors, background was also chosen for evaluation. As with the other study areas, both a SERA and BERA were performed for the background data collected. The results are included in Appendix O (Tables O-315 through O-317 and O-339 through O-341), and in Tables 7-24, 7-25, 7-29, and 7-30. The SERA identified aluminum and manganese at this site, with HQs between 2 and 4. The HI for background based on the screening level assessment was 6.

The BERA for background also identified aluminum (HQ = 2) and manganese (HQ =1). The HI for this area based on the BERA was 3. This is higher than the HI for Talladega Creek (Study Area TA), with no identified risk, and slightly lower than Study Areas 9 and the Coosa River (Study Area CO) (HIs = 4), with small risk to aquatic biota.

7.7.6 Summary of Baseline Risk Characterization

Overall, reliable methods and sufficient data exist to develop and evaluate HQs and reach conclusions about the ecological risk assessment endpoints. Assuming all HQs greater than 10 mean real COCs, the major conclusions are as follows:

- ALAAP exhibits ecological risk
- ALAAP soils, sediment, and surface water show risk to a variety of receptors
- There are eight soil COCs, two sediment COCs, and five surface water COCs.

The SERA and BERA are summarized in Section 7.9.

7.8 UNCERTAINTIES

Uncertainty in the ALAAP ERA is discussed in detail for the four steps of the EPA approach to ERA: problem formulation, exposure assessment, effects assessment, and risk characterization. These are identified and evaluated in **Table 7-31**, where the effect of the uncertainty on the risk assessment is indicated in terms of the likelihood of overestimating or underestimating risk.

7.8.1 Uncertainty in Problem Formulation

There is uncertainty about which substances present in environmental media at ALAAP qualify as COPECs. For instance, some substances are undetectable at contract required detection limits, but may be present at, or accumulate to, toxic concentrations in biota. There also is uncertainty about which organisms potentially exposed at ALAAP are most at risk and are not recognized adequately in the assessment endpoints evaluated in the ERA.

7.8.2 Uncertainty in Exposure Assessment

The primary uncertainties in the exposure assessment concern site-specific and receptor-specific exposure factors. There is uncertainty about the site-specific properties of soil, sediment, and surface water that determine the availability of COPECs to ecological receptors. In addition, there is uncertainty about the receptor-specific exposure parameters determining the magnitude of their exposure to contaminated media (e.g., dietary composition and time spent at site).

Table 7-31. Qualitative Evaluation of Uncertainty for ALAAP ERA Alabama Army Ammunition Plant, Childersburg, Alabama

Source or Area of Uncertainty	Effect on Risk Estimates[a]		
	Potential for Underestimating Risk	Potential for Either Underestimating or Overestimating Risk	Potential for Overestimating Risk
Problem Formulation			
Identification of COPECs		Medium	
Identification of sensitive receptors	Low		
Exposure Assessment			
Site-specific bioavailability of COPECs			Medium
Receptor-specific exposure factors		Low	
Toxicity Assessment			
Use of published toxicity values			Medium
No toxicity values for some contaminants	Medium		
No data on chemical interactions	Medium		
Organismal toxicity used for higher levels of ecological organization			Medium
Risk Characterization			
Ecological risk quotient values			Low
Offsite ecological risk	Low		
Cumulative ecological risk	Low		
Future ecological risk		Low	
Background ecological risk		Medium	

[a] Evaluation given only for potential effect with most serious consequences for ecological risk management decisions.

7.8.3 Uncertainty in Effects Assessment

The major uncertainties in the effects assessment include the effects of extrapolating from published toxicity thresholds for test organisms from the laboratory to the field, the lack of toxicity data for some receptors for some COPECs, the lack of toxicity data for chemical mixtures, and the ecological relevance of organismal toxicity for characterizing risks to populations and habitats. There are also differences between the form of a chemical administered in published toxicity tests and the likely site-specific form (e.g., aluminum chloride and aluminum sulfate versus aluminum oxides).

7.8.4 Uncertainty in Risk Characterization

The uncertainty in the risk characterization is the uncertainty about the actual risk quotient values, and thus, their interpretation in terms of current and future risks to plants and animals at

ALAAP. In addition, there is uncertainty associated with the potential for adverse effects of those COPECs without toxicity data. Four additional areas of uncertainty in the risk characterization are offsite risk, cumulative risk, future risk, and background risk.

Offsite Risk—The risks to offsite receptors cannot be characterized without benefit of contaminant tracer studies and offsite plant, animal, and habitat surveys. Offsite receptors can be exposed to contaminants via physical and organismal transport processes, but evaluating the magnitude of this exposure would require additional studies. It is unlikely that offsite receptors would have lower toxicity thresholds for contaminants than the thresholds used for onsite receptors. In addition, there is little reason to expect that contaminants migrating offsite would be concentrated above measured concentrations at ALAAP unless a contaminant bioconcentrates in organisms that move extensively on and off the study areas. In general, the risk to most offsite receptors is likely to be overestimated rather than underestimated by the risk estimate for onsite receptors.

Cumulative Risk—The ERA estimates the risk to populations of ecological receptors from individual contaminants. However, in nature, receptors are exposed simultaneously to mixtures of chemicals. Generally, the methods used for estimating risks are sufficiently conservative, resulting in individual chemical risks that are overestimated. Nevertheless, cumulative risk is possible when several living plants and animals are affected simultaneously. Harmful effects in ecosystems (including effects on individual organisms) may cascade throughout the system and have indirect effects on the ability of a population to persist in the area even though individual organisms are not sensitive to the given contaminants in isolation. Therefore, the ecological risk characterization for ALAAP may underestimate actual risks to plants and animals from cumulative risks.

Future Risk—A third area of uncertainty in the ecological risk characterization is the future risk to plants and animals from contamination at ALAAP. The ERA characterizes the current risk based on chronic exposure to measured concentrations of contaminants with the potential to persist in the environment for extended periods of time. Risk quotients for vegetation estimate the risk to plant species that would be natural parts of future successional stages at these areas. Nevertheless, possible mechanisms exist that could significantly increase (e.g., erosion, leaching to surface water or groundwater) or decrease (e.g., enhanced microbial degradation) the risk to future plants and animals at the study areas.

Background Risk—Another source of uncertainty is ecological risk relative to background conditions. Although only inorganics with concentrations above background were examined in the COPEC screening, some COPECs are above background only by a statistically insignificant amount; therefore, concentrations at the exposure unit are actually lower than the background concentration. The conservative approach to comparing ALAAP site concentrations to background probably overestimates the risk from COPECs whose source is not associated with a given exposure unit.

The primary sources of uncertainty in the four steps of the ALAAP ERA do not affect the credibility of the risk characterization seriously. The weight of evidence is sufficient to support the conclusions of the risk characterization.

7.8.5 Summary

The most important uncertainties in the ERA are those affecting the estimates of contaminant concentrations to which ecological receptors are actually exposed (exposure concentrations) and concentrations presenting an acceptable risk level of harmful effects (toxicity reference values or thresholds). These uncertainties arise from multiple sources, especially from the lack of exposure unit-specific data on contaminant transport and transformation processes, organismal toxicity, animal behavior and diet, population dynamics, and the response of plant and animal populations to stressors in their environments. Despite these uncertainties, the available exposure unit-concentration data and published exposure and effects information allow ecological COCs (HQs >1) to be identified for each exposure unit.

7.9 SUMMARY OF THE SCREENING AND BASELINE ECOLOGICAL RISK ASSESSMENTS

A SERA (EPA 1997a) and a BERA (EPA 1997a) were performed in accordance with guidance from ADEM, EPA Headquarters, EPA Region IV, and the U.S. Army. This guidance specifies a step-by-step procedure. The SERAs and BERAs conducted for the ALAAP adhere to this guidance and include the following four steps: problem formulation, exposure assessment, effects assessment, and risk characterization, including uncertainties and summarization.

Current risks to ecological receptors at the ALAAP study areas were characterized by evaluating ecological assessment endpoints using risk quotients. Risk quotients are calculated for different receptors for every COPEC for which published information on toxicity threshold concentration is available. Each risk quotient compares two concentrations: the estimated COPEC concentration (RME) in soil, sediment, and surface water to which a given receptor is exposed, and the toxicity threshold concentration for the COC and receptor. The toxicity threshold concentration is a dietary limit or other threshold concentration expected to cause no harm to the receptor, minimal harm with no ecological significance, or minimal harm to a community of organisms (i.e., assemblage of species) exposed to the COPEC in an appropriate medium. Thus, the toxicity threshold is a safe, or protective, concentration.

ALAAP comprises many acres of natural and man-made habitats. Old fields and hardwood forests of varying ages occupy a large portion of the total area. There are many fields and forests at ALAAP study areas whose appearance is similar to fields and forests at reference or background locations. Although it is not sufficient to claim no immediate endangerment, such abundant habitat means that alternate food and cover is available to support organisms without relying on the resources in the exposure unit areas. Also, many organisms were observed, further suggesting no immediate endangerment.

Of the many observed plant and animal taxa, three terrestrial classes (plants and soil-dwelling invertebrates, worm-eating and/or insectivorous mammals and birds, and terrestrial top predators) were selected for terrestrial receptors. For aquatic habitats, three classes were selected (sediment-dwellers, fish and aquatic life, and fish-eating predators).

The following narrative summarizes the major findings of the current and baseline ecological risk assessment.

7.9.1 Summary of Ecological Risks Associated with ALAAP Surface Soils

A SERA was performed on surface soil receptors (vegetation, earthworms, cottontail, shrew, and woodcock) at 18 study area locations and one background location at ALAAP. The SERA identified 14 metals, six organics, and one explosive with HQs >1 for one or more receptors in one or more study areas. All study areas had at least one COPEC identified in the SERA. Study Areas 2, 3, 4, 16, 17, 20, 22, 25, B6, and PS had the highest risk based on risk to the shrew and the woodcock (HIs >1,000), with lead and aluminum being the major contributors to this risk. Aluminum, arsenic, and lead were the most widespread COPECs, occurring with HQs >1 for at least one ecological receptor in more than half of the study areas.

A BERA was performed on the same study areas and background location, and identified as COCs Aroclor-1248, Aroclor-1254, and the 14 inorganic COPECs identified in the SERA. The explosive and remaining organic COPECs identified in the SERA were screened out based on the BERA. There was no identifiable risk in the BERA for some receptors in a number of study areas, as summarized in the following:

- ***Study Area 6***—No risk to vegetation, earthworms, or cottontails
- ***Study Area 7***—No risk to vegetation, earthworms, cottontails, or shrews
- ***Study Area 10E***—No risk to earthworms or cottontails
- ***Study Area 10W***—No risks to earthworms or cottontails
- ***Study Area 18***—No risk to cottontails
- ***Study Area 19***—No risk to earthworms, cottontails, shrews, or woodcocks
- ***Study Area 22***—No risk to cottontails
- ***Study Area 25***—No risk to cottontails or woodcocks
- ***Study Area B6***—No risk to woodcocks
- ***Study Area PO***—No risk to vegetation, earthworms, cottontails, or woodcocks
- ***Study Area PS***—No risk to woodcocks
- ***BK***—No risk to cottontails or shrews.

In summary, there is no ecological risk at Study Area 19. At a number of the other study areas, there is no risk to certain receptors. These include Study Areas 6, 7, 10E, 10W, 18, 22, 25, B6, PO, and PS. The rest of the study areas (Study Areas 2, 3, 4, 8, 16, 17, and 20) have risk to all the ecological receptors investigated. Much of this risk can be attributed to two metals, aluminum

and lead. Risk is relatively higher to the vegetation, and in several study areas, to earthworm ecological receptors. Plants and earthworms are immobile ecological receptors, and the cottontail, shrew, and woodcock are mobile, although they have small home ranges. In each assessment, background exhibits risk comparable to the study areas with the lower range of HIs, clearly showing the difference in risk between immobile and mobile receptors.

Bioassays were taken to set RGOs. This purpose is clearly stated in the Final Supplemental RI/FS Sampling and Analysis Plan/Work Plan Addendum of June 1996 (SAIC 1996c); this is the EPA and ADEM approved work plan. Further, the use of bioassays for RGO development was approved by the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM). The screening and baseline ERAs showed where there was ecological risk—the theoretical probability of harm based on a mathematical approach. The bioassays provided the realism or evidence based on a chemical mixture and measurement approach. This application is found in Section 7.10.

7.9.2 Summary of Ecological Risks Associated with ALAAP Sediment

A SERA was performed on sediment-dwelling biota at eight study areas and one background location at ALAAP. The SERA identified 14 COPECs (arsenic, chromium, copper, lead, manganese, mercury, nickel, zinc, acetone, pyrene, benzo[g,h,i] perylene, benzo[k]fluoranthene, chrysene and ideno[1,2,3-cd]pyrene) with HQs >1 for this receptor class in one or more of six of the eight study areas. Study Areas 5 and 16 had HQs of less than one for all chemicals. Study Area 9 had the greatest diversity of COPECs (all of the above except zinc), and showed the greatest risk based on an HI of 98, almost five times the HI of any other study area. This was due mainly to arsenic and copper, which had HQs of 27 and 33, respectively.

A BERA was performed on the same nine study areas, and identified the same 14 COCs with HQs >1 for sediment-dwelling biota as were identified in the SERA. Both the range of HQs and the HIs were lower in the BERA than in the SERA. The greatest risk to sediment-dwelling biota occurs at Study Areas 9, 21, and 27, thus confirming the results of the SERA.

In summary, there is no ecological risk at two of the study areas (Study Areas 5 and 16). At the other six study areas, ecological risk is small (HQs of 1 to 5 for a few metals, with the exception of Study Area 9). Background exhibits risk (HQs of 1 and 2) comparable to some of the study areas, especially CO and TA.

7.9.3 Summary of Ecological Risks Associated with ALAAP Surface Water

A SERA was performed on aquatic biota, mink, and great blue herons at seven study locations and one background location at ALAAP. The SERA identified eight metals (aluminum, arsenic, barium, cobalt, copper, iron, lead, and manganese), one organic (carbon disulfide) and two explosives (2,4-DNT and TNT) with HQs >1 for one or more receptors in one or more of six of the seven study areas. Talladega Creek (Study Area TA) had HQs of less than one for all chemicals.

Iron (occurring in five study areas), aluminum (occurring in four study areas) and manganese (occurring in four study areas) were the most pervasive COPECs. No risk was identified for great blue herons on the basis of the SERA.

A BERA was performed on the same seven study areas, and identified aluminum, barium, cobalt, copper, iron, lead, manganese, and carbon disulfide as COCs with HQs >1. No risk was identified to mink or great blue herons. The greatest risk to aquatic biota occurs at Study Area 16 (HI = 68), due largely to cobalt (HQ = 47). Study Areas 21, 26, and 27 had HIs ranging from 29 to 43. Aluminum, barium, iron, and manganese had maximum HQs <16 for aquatic biota. Copper, lead, and carbon disulfide all had HQs <2.

In summary, there is no ecological risk from Study Area TA to surface water receptors. At all the other sites (Study Areas 9, 16, 21, 26, 27, and Coosa River), the only risk is to aquatic biota and not to terrestrial predators feeding on aquatic organisms. With the exception of cobalt, all HQs are 15 or less.

Bioassays were taken to set RGOs. This purpose is clearly stated in the Final Supplemental RI/FS Sampling and Analysis Plan/Work Plan Addendum of June 1996 (SAIC 1996c); this is the EPA and ADEM approved work plan. Further, the use of bioassays for RGO development was approved by USACHPPM. The screening and baseline ERAs showed where there was ecological risk—the theoretical probability of harm based on a mathematical approach. The bioassays provided the realism or evidence based on a chemical mixture and measurement approach. This application is found in Section 7.10.

7.9.4 Final Summary

For soil, aluminum and lead are the dominant source of ecological risk at several study areas. There are other metals with lower HQs, but no explosives had HQs >1. There is little or no risk at Study Areas 6, 7, 10E, and 10W. For sediment, only arsenic and copper at Study Area 9 stand out. For surface water, aluminum, barium, cobalt, and manganese show the highest HQs at Study Areas 16, 21, 26, and 27.

7.10 REMEDIAL GOAL OPTIONS BASED ON ECOLOGICAL RISK

This section discusses how ecoRGOs are developed for soil, sediment, and surface water. EcoRGOs are concentrations in soil, sediment, and surface water that are conservative and meant to be protective of sensitive ecological receptors. The ecoRGOs advanced in this section are ALAAP-specific because they are based, in part, on site-specific soil concentrations and site-specific bioassay measurements.

RGOs are developed for terrestrial and aquatic receptors for all BERA-identified COCs with HQs ≥ 10 and COCs with HQs > 1 that exceed ARARs. The RGOs developed in **Tables 7-32** through **7-39** are based on computations and data for the BERA in the Phase 1 Supplemental RI. For soil, RGOs are developed for aluminum, cadmium, chromium, copper, lead, nickel, vanadium, and zinc. Sediment RGOs are developed for aluminum and copper, and surface water RGOs are developed for aluminum, barium, cobalt, copper, iron, lead and manganese. **Tables 7-40** through **7-42** incorporate the results of ALAAP bioassays into the development of these RGOs.

RGOs are calculated for COCs with HQs ≥ 10 because there is a high degree of confidence that these COCs actually pose a risk to ecological receptors. In the BERA (Section 7.7), the HQ is calculated as the ratio of the average exposure point concentration or dose and a toxicity threshold equivalent to a concentration or dose associated with some level of adverse effect (e.g., LOAEL). In general, baseline HQs ≥ 1 indicate that some individual receptors are likely exposed at levels that caused an adverse effect of the type measured as the endpoint of the toxicity test from which the LOAEL was derived. According to EPA guidance, it is important to consider the uncertainty in the baseline HQ before a decision is made to identify a substance as a COC. There is uncertainty about the true value of the exposure dose and effects thresholds used to calculate HQs, and thus the HQ itself. As a result of these uncertainties, the true value of the HQ for a given substance and receptor at a particular study area lies in a range of values around the calculated HQ. Although the size of this range or "gray area" varies for different COCs and receptors and is difficult to quantify, the more the calculated HQ exceeds 1 the more likely the true HQ value also exceeds 1. This motivates a focus on COCs with HQs ≥ 10 to reduce the likelihood of a false positive error – concluding that there is a risk when there is not. The focus on HQs ≥ 10 is meant to balance the suspected but unquantified sources of conservative bias in exposure estimates (e.g., overestimated bioavailability, conservative diets, and area use factors) and effect estimates (e.g., laboratory-based benchmarks and ecological screening values).

7.10.1 Soil

Risk-based ecoRGOs for soil are calculated by methods similar to those used for risk assessment. However, instead of calculating the risk from dietary exposure to soil contaminants at the existing environmental concentrations, the method calculates the highest environmental concentration at which the risk from COCs in soil is not harmful to biological individuals, ecological populations, or communities.

This ecoRGO development is limited to 11 soil COCs. Of these none is an ARAR, eight exhibit an HQ ≥ 10, and the remainder (arsenic, mercury, and 2,4,-DNT) are substances of interest during the development of the ALAAP RI over the past 5 years. There also are some modifications of exposure and toxicity parameters from those used in the risk assessment. Those modifications are stated and documented in the following subsections, along with summaries of parameters used with no substantial changes from that earlier ERA work.

Table 7-32. Exposure Factors for RGO Calculations Alabama Army Ammunition Plant, Childersburg, Alabama

Receptors	Exposure Parameters					
	SI	AEs	PI	TI	AEt	EF
Short-tailed shrew	0.3	0.1	0	0.7	1	$(0.3 \times 0.1) + (0.7 \times BAF_i)$
Eastern cottontail	0.08	0.1	0.92	0	1	$(0.08 \times 0.1) + (0.92 \times BVT)$
American woodcock	0.45	0.1	0	0.55	1	$(0.45 \times 0.1) + (0.55 \times BAF_i)$
White-tailed deer	0.02	0.1	0.98	0	1	$(0.02 \times 0.1) + (0.98 \times BVT)$
Red fox	0.03	0.1	0	0.97	1	$(0.03 \times 0.1) + (0.97 \times BAF_a)$
Red-tailed hawk	0	0.1	0	1	1	$(1 \times BAF_a)$

EF – Exposure factor
SI – Fraction of daily diet that is soil ingestion
AEs – Absorption efficiency (fraction of contaminant absorbed from ingested soil)
PI – Fraction of daily diet that is plant tissue
TI – Fraction of daily diet that is animal tissue
BVT – Bioaccumulation factor from soil to plant vegetative tissue
BAF_i – Bioaccumulation factor from soil to invertebrate (earthworm) tissue
BAF_a – Bioaccumulation factor from soil to animal tissue
AEt – Absorption efficiency (fraction of contaminant absorbed from ingested tissue)

Table 7-33. Bioaccumulation Factors for RGO Development Alabama Army Ammunition Plant, Childersburg, Alabama

Contaminant of Concern	BVT [a]	BAF_i [b]	BAF_a [b]
Aluminum	8.0×10^{-4}	7.5×10^{-2}	7.5×10^{-2}
Arsenic	8.0×10^{-3}	6.6×10^{-3}	1.0×10^{-1}
Cadmium	1.1×10^{-1}	1.1×10^{1}	2.8×10^{-2}
Chromium	1.5×10^{-3}	1.6×10^{-1}	2.8×10^{-1}
Copper	8.0×10^{-2}	1.6×10^{-1}	5.0×10^{-1}
Lead	9.0×10^{-3}	1.7×10^{-1}	1.5×10^{-2}
Mercury	1.8×10^{-1}	3.4×10^{-1}	1.3×10^{1}
Nickel	1.2×10^{-2}	2.3×10^{-1}	3.0×10^{-1}
Vanadium	1.1×10^{-3}	1.3×10^{-1}	1.3×10^{-1}
Zinc	3.0×10^{-1}	1.8	5.0
2,4-Dinitrotoluene	3.26	46	1.29×10^{-6}

a Data from Baes et al. 1986, except 2,4-DNT BVT from Travis and Arms 1988.
b Data from HAZWRAP 1994, except 2,4-DNT BAF_i from Lord et al. 1980 and 2,4-DNT BAF_a from Ng 1982.

Table 7-34. Dietary Toxicity Thresholds for RGO Development Alabama Army Ammunition Plant, Childersburg, Alabama

Ecological COCs	Receptors							
	Plant[a]	Earthworm[a]	Short-tailed shrew[b]	Eastern cottontail[b]	American woodcock[b]	White-tailed deer[b]	Red fox[b]	Red-tailed hawk[b]
Aluminum	50	ND[c]	38.3	38.8	1,361	94.5	55.2	827
Arsenic	10	60	2.5	2.53	25.3	6.17	3.6	15.4
Cadmium	3	20	36.6	37.1	39.6	90.5	52.8	24
Chromium[d]	1[e]	0.4[e]	100,257	101,585	10.5	247,695	144,540	6.35
Copper	100	50	72.1	73.1	104	178	104	63.4
Lead	50	500	293	297	44.4	724	423	26.9
Mercury[f]	0.3	0.1	48.1	48.7	1.1	119	69.4	0.67
Nickel	30	200	293	297	212	724	422	129
Vanadium	2	ND[c]	7.7	7.8	225	19	11.1	137
Zinc	50	200	1,172	1,188	306	2,896	1,690	186
2,4-Dinitrotoluene	ND[c]	ND[c]	268	271	ND[c]	661	386	ND[c]

[a] Threshold soil concentrations for plants and earthworms (mg/kg soil)
[b] LOAEL dietary exposure thresholds (mg/kg diet) for mammals and birds
[c] ND = no data available
[d] Based on toxicity reference values for trivalent chromium, unless otherwise noted
[e] Based on toxicity reference values for hexavalent chromium
[f] Based on toxicity reference values for mercuric chloride

Table 7-35. RGOs (mg/kg) for Contaminants in Soil Alabama Army Ammunition Plant, Childersburg, Alabama

Ecological COCs	Receptors							
	Plant	Earthworm	Short-tailed shrew	Eastern cottontail	American woodcock	White-tailed deer	Red fox	Red-tailed hawk
Aluminum	50	ND	464	4,437	15,792	33,947	728	11,024
Arsenic	10	60	72	165	522	627	36	154
Cadmium	3	20	4.7	340	6.5	824	1751	858
Chromium[a]	1[b]	0.4[b]	706,040	NA	79	NA	526,366	23
Copper	100	50	508	895	785	2,216	213	127
Lead	50	500	1,967	18,239	320	66,912	24,073	1,795
Mercury[c]	0.3	0.1	179	281	4.8	666	5.5	0.05
Nickel	30	200	1,534	15,595	1,235	52,616	1,437	428
Vanadium	2	ND	64	865	1,933	6,174	86	1,052
Zinc	50	200	909	4,182	295	9,784	348	37
2,4-Dinitrotoluene	ND	ND	8.3	90	ND	208	128,531	ND

ND = no data available
NA = not applicable because concentration exceeds 1×10^6 mg/kg
[a] Based on toxicity reference values for trivalent chromium, unless otherwise noted
[b] Based on toxicity reference values for hexavalent chromium
[c] Based on toxicity reference values for mercuric chloride

Table 7-36. Lowest RGOs (mg/kg soil) for Receptor Groups Alabama Army Ammunition Plant, Childersburg, Alabama

Ecological COCs	Receptors	
	Soil dwellers (plants and earthworms)	Non-soil dwellers (mammals and birds)
Aluminum	50	464
Arsenic	10	36
Cadmium	3	5
Chromium	0.4	23
Copper	50	127
Lead	50	320
Mercury	0.1	0.05
Nickel	30	428
Vanadium	2	64
Zinc	50	37
2,4-Dinitrotoluene	ND	4

ND = no data available

Table 7-37. Summary of EcoRGOs (mg/kg) and Other Data Leading to Recommended EcoRGOs Alabama Army Ammunition Plant, Childersburg, Alabama

COC	RME Background (1999)	LOAEL-based and Site-related EcoRGO (December 28)		Highest Measured Soil Concentration Associated with a No Effect Soil Bioassay	EcoRGO Based on Immobile Soil Dweller		EcoRGO Based on Mobile Nonsoil Dweller	
		Immobile Soil-dwellers (e.g., plants and earthworms)	Mobile Nonsoil Dwellers (e.g., mammals and birds)		Concentration Believed to be Protective	Justification	Concentration Believed to be Protective	Justification
Aluminum	13,401	50	464	22,500	22,500	Bioassay	13,401	Background
Arsenic	8.4	10	36	12.7	13	Bioassay	36	Nonsoil-dweller
Cadmium	<0.427	3	5	1	3	Soil-dweller EcoRGO	5	Nonsoil-dweller
Chromium	35	0.4	23	84.1	84	Bioassay	23	Nonsoil-dweller
Copper	8.2	50	127	115	115	Bioassay	127	Nonsoil-dweller
Lead	20	50	320	43.4	50	Soil-dweller EcoRGO	320	Nonsoil-dweller
Mercury	0.03	0.1	0.05	0.2	0.2	Bioassay	0.05	Nonsoil-dweller
Nickel	6.9	30	428	13.9	30	Soil-dweller EcoRGO	428	Nonsoil-dweller
Vanadium	52	2	64	71.5	72	Bioassay	64	Nonsoil-dweller
Zinc	31	50	37	451	451	Bioassay	37	Nonsoil-dweller
2,4-DNT	0	ND	4	21.3	21.3	Bioassay	4	Nonsoil-dweller

COC – Chemical of concern
ecoRGO – Ecological remedial goal option
LOAEL – Lowest-observable-adverse-effects-level
NOAEL – No-observable-adverse-effects-level
RME – Reasonable maximum exposure
ND – No Data

Table 7-38. Summary of Sediment EcoRGOs (µg/g) and Other Data Leading to Recommended EcoRGOs Alabama Army Ammunition Plant, Childersburg, Alabama

COC	RME Background (1999)	Benthic Effects-based RGO[a]	Highest Detected Sediment Concentration Associated with a Little or No Effect Sediment Bioassay	Recommendation for EcoRGO	
				Sediment Concentration Believed to be Protective	Justification
Aluminum	15,990	—[b]	13,000	15,990	Background
Arsenic	8.4	8[c]	<12.7[d]	8[e]	ER-L
Cadmium	<0.427[d]	1.2[c]	<0.427[d]	1.2[e]	ER-L
Chromium	26	81[c]	20.2	81[e]	ER-L
Copper	28	34[c]	23	34[e]	ER-L
Iron	31,540	20,000[f]	22,800	31,540	Background
Lead	33	47[c]	17.9	47[e]	ER-L
Mercury	<0.087[d]	0.15[c]	<0.087[d]	0.15[e]	ER-L
Molybdenum	<4[d]	—[b]	<4[d]	—[b]	—[b]

[a] NOAA ER-L or MOE benchmark values
[b] Insufficient data
[c] ER-L – Effects Range-Low
[d] Detected at less than the CRL
[e] ER – Ls normally used as screening values are used here in absence of specific information.
[f] MOE benchmark

Table 7-39. Summary of Surface Water (µg/L) EcoRGOs and Other Data Leading to Recommended EcoRGOs Alabama Army Ammunition Plant, Childersburg, Alabama

COC	RME Background (1999)	Regulatory Benchmark	Highest Measured Surface Water Concentration Associated with a Little or No Effect Bioassay	Recommendation for EcoRGO	
				Surface Water Concentration Believed to be Protective	Justification
Aluminum	360	87[b]	3,660	87	ARAR
Barium	52	3.8[a]	42.3	52	Background
Cobalt	ND[c]	62[a]	NA	62	Tier II
Copper	ND[c]	10.7[b]	NA	11	ARAR
Iron	393	1,000[b]	2,290	1,000	ARAR
Lead	ND[c]	2.74[b]	1.26	3	ARAR
Manganese	244	80[a]	2,140	2,140	Bioassay
Zinc	ND[c]	110[b,d]	LT 21.1	110	ARAR

[a] EPA Tier II value
[b] ADEM freshwater chronic water criterion
[c] Not detected at CRL
[d] Hardness-dependent criterion normalized to 100 mg $CaCo_3$/L

Table 7-40. Summary of Soil EcoRGOs (mg/kg) and June 1996 Bioassays Alabama Army Ammunition Plant, Childersburg, Alabama

COC	Recommended EcoRGO Based on Immobile Soil-Dweller (plants, earthworms) 1995		Revised EcoRGO Based on Immobile Soil-Dweller (plants, earthworms) per 1996 Bioassays	
	Concentration Believed to be Protective	Justification	Soil Concentration Believed to be Protective	Justification
Aluminum	22,500	Bioassay	22,500	Bioassay
Arsenic	13	Bioassay	—[a]	—[a]
Cadmium	3	Soil-Dweller EcoRGO	—[a]	—[a]
Chromium	84	Bioassay	—[a]	—[a]
Copper	115	Bioassay	320	Bioassay
Lead	50	Soil-Dweller EcoRGO	—[a]	—[a]
Mercury	0.2	Bioassay	—[a]	—[a]
Nickel	30	Soil-Dweller EcoRGO	—[a]	—[a]
Vanadium	72	Bioassay	—[a]	—[a]
Zinc	451	Bioassay	—[a]	—[a]
2,4-DNT	21.3	Bioassay	—[a]	—[a]

COC – Ecological chemical of concern
EcoRGO – Ecological remedial goal option
—[a] – No field measurement needed based on examination of 1995 soil data

Table 7-41. Summary of Sediment EcoRGOs (mg/kg) and June 1996 Bioassays Alabama Army Ammunition Plant, Childersburg, Alabama

COC	Recommendation for EcoRGO 1995		Revised per 1996 Bioassays	
	Sediment Concentration Believed to be Protective	Justification	Sediment Concentration Believed to be Protective	Justification
Aluminum	15,900	Background	15,900	Background
Arsenic	8[b]	ER-L[a]	504[a]	Bioassay
Cadmium	1.2[b]	ER-L	—[d]	—[d]
Chromium	81[b]	ER-L	—[d]	—[d]
Copper	34[b]	ER-L	—[d]	—[d]
Iron	31,540	Background	83,200	Bioassay
Lead	47[b]	ER-L	47	ER-L
Mercury	0.15[b]	ER-L	0.21	Bioassay
Molybdenum	—[c]	—[c]	—[d]	—[d]

[a] ER-L – Effects Range-Low
[b] ER-Ls normally used as screening values are used here in absence of specific information
[c] Insufficient data
[d] No field measurement needed based on examination of 1995 sediment data

Table 7-42. Summary of Surface Water EcoRGOs (µg/L) and June 1996 Bioassays Alabama Army Ammunition Plant, Childersburg, Alabama

COC	Recommendation for EcoRGO 1995		Revised per 1996 Bioassays	
	Surface Water Concentration Believed to be Protective	Justification	Surface Water Concentration Believed to be Protective	Justification
Aluminum	87	ARAR	—[c]	—[c]
Barium	52	Background	70	Bioassay
Cobalt	62	Tier II[d]	—[c]	—[c]
Copper	11	ARAR[a]	—[c]	—[c]
Iron	1,000	ARAR[a]	1,000[d]	ARAR[a]
Lead	3	ARAR	—[c]	—[c]
Manganese	2,140	Bioassay	3,350	Bioassay
Zinc	110	ARAR[a,b]	—[c]	—[c]

[a] ADEM freshwater chronic water criterion
[b] Hardness-dependent criterion normalized to 100 mg $CaCo_3$/L
[c] No field measurement needed based on examination of 1995 surface water data
[d] Note that 1996 bioassay showed 4,250 µg/L as being protective

7.10.1.1 Problem Formulation

EcoRGOs are intended to provide exposures that do not have significant adverse effects on individuals and populations of ecological receptors at ALAAP sites. The conceptual site model of exposure to soil COCs at ALAAP is presented in Section 7.3.3 and was used in the development of ecoRGOs. Representative ecological receptors are identified in Section 7.4.5. These receptors represent physiologically similar biota groups exposed to contaminants by similar exposure routes and resulting from common dietary patterns. Plants and earthworms were chosen as representatives of biota exposed continuously or nearly continuously to soil and unable or unlikely to move out of the contaminated area in which they live. Eastern cottontail and white-tailed deer were chosen as herbivores with various home ranges. Short-tailed shrew and American woodcock were chosen as mid-level predators (i.e., carnivores with small home ranges, preying predominantly on biota with small home ranges). Red fox and red-tailed hawk represent top predators (i.e., carnivores with home ranges much larger than an individual study area at ALAAP).

COCs for soil are identified in Section 7.6 and summarized in Section 7.9. These COCs are contaminants whose mean concentrations at a given site resulted in an HQ above 10. Aluminum, arsenic, cadmium, copper, lead, mercury, nickel, vanadium, zinc, and 2,4-DNT were identified as COCs following the Phase 1 investigation in late 1995. In 1999, the only new one is chromium; arsenic, mercury and 2-4 DNT are no longer COCs but are retained here for historical reasons.

7.10.1.2 Exposure Factors and Variables

The dietary exposure of herbivores and predators depends on the amounts and types of food in their diets and on contaminant uptake rates by the food items. Exposure factors for ALAAP biota were used for the calculation of ecoRGOs. The exception was with ecoRGO development, where the parameter DI, the fraction of total ingested substances coming from a specific exposure unit, was always assumed to be 1.0. This assumption was made to ensure protection of biota with dietary exposures similar to those of the representative receptors, but having smaller home ranges (e.g., robins, which may have a similar diet to woodcocks but a smaller home range). Exposure factors used to calculate ecoRGOs are provided in Table 7-32 and bioaccumulation factors are provided in Table 7-33.

Bioaccumulation factors for inorganic chemicals were taken from published literature (Baes et al. 1986, HAZWRAP 1994) and are presented in Table 7-33. For 2,4-DNT, the BVT is calculated as a function of the octanol-water partitioning coefficient, K_{ow} (Travis and Arms 1988), where the K_{ow} is estimated from the organic carbon partitioning coefficient (K_{oc}) according to Lyman et al. (1990). The K_{oc} for 2,4-DNT is 44.7 (ASTDR 1989).

The value of BAF_i for 2,4-DNT is also estimated from the K_{oc}, the fraction of soil that is organic carbon (F_{oc}) and an empirical relationship described by Lord et al. (1980). The value for F_{oc} used in this calculation was the mean of 10 samples taken from various locations at ALAAP. Those 10 samples had the following parameters: minimum = 1.5%, maximum = 6.3%, mean = 3.9%, and standard deviation = 1.4%. The value of BAF_a for 2,4-DNT was taken from Ng (1982).

7.10.1.3 Effects Evaluation

One of the goals of remediation of the environment is to protect terrestrial ecosystems, communities, and populations (policy goal 2, Table 7-2). To do so, it is not necessary to protect individuals as it is when threatened or endangered species are to be protected (policy goal 1, Table 7-2). Therefore, it is not necessary to use an effects threshold that protects each individual from adverse effects (the NOAEL). Instead, it is reasonable to use the lowest exposure concentration that can be shown, reliably, to cause an adverse effect on individuals in the test population (the LOAEL). Toxicity threshold values used for derivation of ecoRGOs for mammals and birds were either reported LOAEL values or estimated LOAEL values calculated by multiplying chronic NOAEL values by 10. Because most plant and earthworm benchmarks were based on observed adverse effects (Will and Suter 1994a, 1994b), those benchmarks were retained as thresholds for ecoRGO development. Toxicity data for birds and mammals were presented in Sample et al. (1996). Toxicity thresholds used for ecoRGO development are presented in Table 7-34. Except for the lead benchmark for birds, these toxicity thresholds are derived using the TRV used in the BERA. For the lead RGO, the benchmark for metallic lead was used because of the nature of the lead contamination in soil at the site. Thresholds were estimated for each receptor by applying allometric corrections for body size and food ingestion rates as described by Sample et al.

(1996). For consistency with the BERA, a body-weight scaling exponent of 0.25 was used for both mammals and birds.

7.10.1.4 Calculation of Risk-Based EcoRGOs

Risk-based ecoRGOs were derived by two methods: modeling of exposure to determine the highest soil concentration that would not cause the exposure threshold to be exceeded for each receptor; and determining the highest soil concentration of each COC in soil that did not exhibit toxicity in ambient toxicity tests.

EcoRGOs from Modeled Risk—EcoRGOs are derived from modeled exposure and estimated toxicity thresholds by a rearrangement of the HQ equation presented in Section 7.6.1. That equation is as follows:

$$HQ = \frac{\text{Environmental Concentration} \times \text{Exposure Variables}}{\text{Toxicity Threshold Concentration}}$$

The ecoRGO is the environmental concentration of a contaminant at which the HQ is 1, so the equation is rearranged to the following:

$$RGO = \frac{\text{Toxicity Threshold Concentration}}{\text{Exposure Factor}}$$

Using the exposure factors in Table 7-32, the bioaccumulation factors in Table 7-33, and the toxicity threshold data in Table 7-34, ecoRGOs were calculated for each receptor (Table 7-35). The lowest ecoRGOs for each COC for the vegetation and for the more mobile biota are presented in Table 7-36.

There are two major sources of uncertainty in the ecoRGOs calculated from exposure factors and estimated toxicity thresholds: representativeness of the contaminated soil used in toxicity tests, and the fraction of the contaminant that is bioavailable at the site. Laboratory toxicity tests typically are conducted by adding solutions of the test chemicals to soil rather than by using soil that has undergone leaching and weathering so that contaminants are at equilibrium with other soil components. In addition, analysis of chemicals in soil involves destructive extraction of the soil that is unlikely to give an accurate estimate of the concentrations of chemicals readily available for uptake by biota. Ambient toxicity tests use site-specific soil having the same properties of bioavailability as the soil to which onsite biota are exposed. Therefore, the results of soil toxicity tests, especially when the tests show no toxicity, are a more reliable indication of site-specific toxicity than the results of toxicity modeling.

EcoRGOs from Site-specific Ambient Toxicity Tests—Toxicity testing (seed germination and earthworm viability and growth) was conducted on soil samples collected from Study Areas 7, 8, 17, 16/19, and the background or reference location in the northeast part of Area A. No toxicity

was observed in any of the soil samples. The concentrations of COCs in samples used for toxicity testing are presented in Table O-342 in Appendix O. When more knowledge about the locations of the highest concentrations was available, additional samples were collected for bioassays. From work on a draft FS (from circa 1996), it was learned that only some of the study areas showed concentrations of COCs higher than their RGOs. Therefore, selected COCs were analyzed in the media samples for bioassays. Table 7-40 summarizes the results of the Phase 2 (1996) bioassays as they influence the RGOs for the immobile or soil-dwelling receptors. The highest concentration of each COC in a soil sample that caused no toxicity was assumed to be a conservative ecoRGO; higher concentrations might also be shown to be nontoxic if they were tested.

7.10.1.5 Conclusions

EcoRGOs were calculated for a variety of receptors representing different trophic groups, ecological exposure rates, and sensitivities to toxicants. Assumptions based on literature toxicity data and exposure data were used to model ecoRGOs, and direct testing of the toxicity of ALAAP soil to plants and earthworms was used to determine if the modeled results were overly or insufficiently conservative for those receptors. In every case where the maximum COC concentration in tested soil exceeded the modeled ecoRGO, the soil was found not to be toxic. Therefore, it was concluded that the results of site-specific toxicity testing are a better measure of toxicity than the modeled results. Accordingly, if the highest concentration of a COC in tested soil exceeded the modeled ecoRGO, the site-specific concentration is recommended as the ecoRGO.

Tables 7-37 and 7-40 present the lowest ecoRGO for each COC and each receptor group at ALAAP. The recommended ecoRGOs (Table 7-40) would protect the most sensitive receptors at possible risk at the ALAAP sites.

7.10.2 Sediment

EcoRGOs for sediment are based on: RME background concentrations, potential effects benchmarks for benthic biota, or concentrations associated with sediments that were not toxic in site-specific bioassays.

Effects-based benchmarks are ER-L values presented by Long et al. (1994), except for iron, which has no ER-L. ER-Ls were derived by ranking chemical concentrations in naturally occurring sediments that were shown to have adverse effects to benthic species and choosing the lowest 10th percentile concentration (Long et al. 1994). They are intended as screening values that, if exceeded, indicate the need to carry out site-specific toxicity testing. The effects benchmark for iron is the low-range value presented by the Ontario Ministry of the Environment (Persaud et al. 1993). No effects-based benchmark was available for aluminum and molybdenum.

Site-specific bioassay results showed slight toxicity of some sediment samples to the test species, *Hyalella azteca*. Sites that showed slight toxicity were resampled, and the repeat bioassays showed no toxicity.

The concentrations of COCs in sediment samples associated with samples used for site-specific bioassays are shown in Table O-343 in Appendix O. Arsenic and cadmium were not detected in any of the three samples; mercury was not detected in one sample; and mercury and lead were both detected at less than the contract required reporting limit (CRL) in two of the three samples. The CRL is generally above the detection limit of the method because a chemical can be detected at concentrations below that at which it can be reliably quantified. As specified by EPA protocols, when a CEB is detected but is found to be below the CRL, its presence is reported less than (LT) the numerical value of the CRL. Values reported as LT were not used as ecoRGOs if there was another, more reliable value available.

Table 7-38 presents the background, effects-based benchmarks, and bioassay-related values, along with ecoRGOs developed earlier in the RI process for ALAAP sediments. Table 7-41 summarizes the results of the Phase 2 (1996) bioassays. When background for a COC was above its ER-L or bioassay-related value, background was chosen as the ecoRGO, because it is not reasonable to clean up to concentrations below naturally occurring background. When a detected bioassay-related value was the highest, it was chosen as the ecoRGO, because toxicity was slight and the toxicity tests were performed on benthic biota that represent sensitive populations in sediment. The benthic effects-based value (ER-L) was used as the ecoRGO when it was higher than background and the bioassay-related value because these values are deemed protective.

7.10.3 Surface Water

EcoRGOs for surface water are based on background concentrations, effects-based benchmarks, or concentrations associated with surface water samples that were not toxic in site-specific bioassays. Effects-based benchmarks are ADEM and EPA Tier II benchmark values for aquatic biota. Aquatic effects benchmarks are expressed for both chronic and acute exposure, where acute exposure is defined for the minimum 1-day low flow that would occur in a 10-year period and chronic exposure is defined for the minimum 7-day low flow that would occur in a 10-year period. Chronic benchmarks were chosen for consideration as ecoRGOs because attaining acute benchmarks, which are higher than chronic benchmarks, would not protect against chronic aquatic exposure.

The concentrations of COCs in surface water samples collected at the same locations as samples used for site-specific bioassays are shown in Table O-344 in Appendix O. Zinc was detected in only one sample, BW-21-002, at a concentration below the CRL. The other COCs were detected in all samples. Aluminum was detected in one background sample (BW-BK-002). Lead was detected in only one sample (BW-21-002) above the CRL.

Table 7-39 presents the background, effects-related regulatory benchmarks, and bioassay-related values. When there were ARARs (ADEM chronic values presented in Table 7-1) that were below bioassay values (e.g., iron), the chronic ARARs were chosen as RGOs because ARARs are assumed to take precedence over values related to site-specific effects. When the background value was above an effects benchmark that is not an ARAR and above the bioassay

value (i.e., for barium), the background value was chosen as the ecoRGO. When the bioassay-related value was above background and ARARs did not apply (i.e., for manganese), the bioassay-related value was used as the ecoRGO. Table 7-42 summarizes the results of the Phase 2 (1996) bioassays.

7.10.4 Master Summary

EcoRGOs were developed for the COCs at ALAAP with HQs ≥ 10 in soil, sediment, and surface water and those with HQs ≥ 1 and exceeding ARARs. Data both from other locations and ALAAP were used to develop these ecoRGOs. The recommended soil RGOs based on mobile non-soil dwelling receptors are as follows:

- ***Aluminum***—13,400 mg/kg
- ***Arsenic***—36 mg/kg
- ***Cadmium***—5 mg/kg
- ***Chromium***—23 mg/kg
- ***Copper***—127 mg/kg
- ***Lead***—320 mg/kg
- ***Mercury***—0.05 mg/kg
- ***Nickel***—428 mg/kg
- ***Vanadium***—64 mg/kg
- ***Zinc***—37 mg/kg
- ***2,4-DNT***—4 mg/kg.

Soil RGOs for nonmobile or soil dwellers are as follows:

- ***Aluminum***—22,500 mg/kg
- ***Arsenic***—13 mg/kg
- ***Cadmium***—3 mg/kg
- ***Chromium***—84 mg/kg
- ***Copper***—320 mg/kg
- ***Lead***—50 mg/kg
- ***Mercury***—0.2 mg/kg
- ***Nickel***—30 mg/kg
- ***Vanadium***—72 mg/kg
- ***Zinc***—451 mg/kg
- ***2,4-DNT***—21 mg/kg.

The RGOs for sediment are as follows:

- ***Aluminum***—15,900 mg/kg
- ***Arsenic***—504 mg/kg

- ***Cadmium***—1.2 mg/kg
- ***Chromium***—81 mg/kg
- ***Copper***—34 mg/kg
- ***Iron***—83,200 mg/kg
- ***Lead***—47 mg/kg
- ***Mercury***—0.15 mg/kg
- ***Molybdenum***—insufficient data.

The RGOs for surface water are as follows:

- ***Aluminum***—87 µg/L
- ***Barium***—70 µg/L
- ***Cobalt***—62 µg/L
- ***Copper***—11 µg/L
- ***Iron***—1,000 µg/L
- ***Lead***—3 µg/L
- ***Manganese***—3,350 µg/L
- ***Zinc***—110 µg/L

These are believed to be conservative values and can be used with confidence that they protect ecological receptors.

8. CONCLUSIONS AND RECOMMENDATIONS

This section summarizes the results of the Supplemental Remedial Investigation (RI) conducted by Science Applications International Corporation (SAIC) at Area B of the Alabama Army Ammunition Plant (ALAAP) and presents overall conclusions and recommendations for each study area. The section focuses on the chemicals of concern (COCs) identified in the quantitative ecological and human health risk assessments.

In the human health risk assessment, noncancer and cancer risks were estimated for exposures to soil, groundwater, sediment, surface water, rabbit, and fish tissue. The scenarios under which these exposures were evaluated include current and future industrial land use, future construction land use, future recreational land use, and future residential land use. Under the industrial and construction worker scenarios, the exposed receptors are adult workers. Under the residential and recreational scenarios, the exposed receptors are adults and children who live and participate in recreational activities in the areas under investigation. Uncertainty in the human health risk assessment is inherent in every step of the risk process. As discussed in Section 6.5, uncertainty may be associated with the environmental sampling and analysis of monitoring data, the exposure assessment, the toxicity assessment, and the risk characterization. The general bias of the risk assessment is to err on the side of conservatism although many of the sources of uncertainty have the potential to either overestimate or underestimate risk.

The ecological risk assessment consisted of both screening and baseline types. In each, a number of land-based (i.e., terrestrial) and water-based (i.e., aquatic) receptors from a range of trophic positions were evaluated. For example, terrestrial receptors included vegetation, earthworms, rabbits, deer, shrews, woodcocks, red foxes and red-tailed hawks and represented plants, plant-eaters (i.e., herbivores) and flesh-eaters (i.e., carnivores). Aquatic receptors included vegetation, sediment-dwelling organisms (e.g., crayfish), aquatic animals (e.g., golden shiners), and fish-eating predators (e.g., great blue herons and mink). Habitat maps, actual measurements of tissues, and bioassays of several organisms were performed to add realism to the risk assessments.

EPA has established target risk levels for use in determining the need for remediation. The risk characterization calculates risks and compares these to target levels. If these levels are exceeded, the COCs responsible for the exceedances are identified. COCs were identified in the human health risk assessment if a chemical (or chemicals) significantly contributed to a pathway that exceeded a 1×10^{-4} cancer risk or a hazard index (HI) of 1. In the ecological risk assessment, COCs were identified if the hazard quotient (HQ) exceeded 1 for soil, sediment, and surface water.

Summaries and conclusions for each study area are provided in Section 8.1 along with recommendations for further action for soil, sediment, and surface water at individual study areas. Section 8.2 presents a broader discussion of the media evaluated across Area B (i.e., groundwater, soil, sediment, and surface water). Section 8.3 presents a summary of the

human health remedial goal options (HHRGOs) and ecological remedial goal options (ecoRGOs) that have been developed for ALAAP – Area B. These remedial goal options (RGOs) will be further considered in the feasibility study (FS) for ALAAP.

8.1 STUDY AREA AND CERFA SITE SUMMARIES AND RECOMMENDATIONS

This section summarizes the significant findings for each study area and Community Environmental Response Facilitation Act (CERFA) site investigated during the Supplemental RI.

The basis for the recommendations for each study area and the CERFA sites are highlighted in this section. Recommendations for soil at each study area are summarized in **Table 8-1**. **Table 8-2** summarizes the recommendations for sediment at the applicable study areas. **Table 8-3** summarizes the recommendations for surface water at the applicable study areas. Recommendations are based on human health (for both the likely and the most conservative land use scenarios) and ecological risk assessments. Industrial land use is the intended future land use of Area B according to the Site Management Plan prepared by the U.S. Army Environmental Center (USAEC) for ALAAP (USAEC 1995b). Because future industrial use of the land could require construction of buildings or other structures, the construction scenario risk results are important contributions to the conclusions and recommendations. Therefore, conclusions and recommendations for further actions are presented in this Supplemental RI Report for the most likely future land use (i.e., industrial and construction). In addition, conclusions and recommendations are presented for each of the study areas for the most conservative land use (i.e., residential) in accordance with U. S. Environmental Protection Agency (EPA) guidance. The final assessment of the need for remediation at ALAAP – Area B will be made through risk management decisions.

Groundwater beneath the main industrial portion of Area B contains concentrations of nitroaromatics and metals that result in sufficiently high risk estimates to indicate that any use of the untreated groundwater would result in risks above EPA targets. Metals (arsenic, beryllium, lead, and nickel) and organics (carbon tetrachloride, pentachlorophenol [PCP], bis[2-ethylhexyl]phthalate [B2EHP], and vinyl chloride) were detected at concentrations that exceed the maximum contaminant levels (MCLs). Due to the significant groundwater contamination detected within Area B, additional investigations are being conducted. Recommendations for groundwater will be provided in a subsequent report.

8.1.1 Study Area 2 – Smokeless Powder Facility

Soil

- Nineteen metals were detected at concentrations that exceeded background.

Table 8-1. Recommendations for Soil
Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area No.	Study Area	Protection of Human Health		Protection of Ecological Resources[a]
		Likely Land Use (Industrial and Construction)	Most Conservative Land Use (Residential)	
2	Smokeless Powder Facility	Evaluate in FS.	Evaluate in FS.	Evaluate in FS.
3	Sanitary Landfill and Lead Facility	No further action.	Evaluate in FS.	Evaluate in FS.
4	Manhattan Project Area	Evaluate in FS.	Evaluate in FS.	Evaluate in FS.
6	Southern TNT Manufacturing Area	No further action. Site has been remediated.	No further action. Site has been remediated.	No further action[b]. Site has been remediated.
7	Northern TNT Manufacturing Area	No further action. Site has been remediated.	No further action[b]. Site has been remediated.	No further action[b]. Site has been remediated.
8	Acid/Organic Manufacturing Area	Evaluate in FS.	Evaluate in FS.	Evaluate in FS.
8	Acid/Organic Manufacturing Area – Test Pits	Evaluate in FS.	Evaluate in FS.	No further action.
10–East	Tetryl Manufacturing Area	Evaluate in FS.	Evaluate in FS.	Evaluate in FS.
10–West	Tetryl Manufacturing Area	No further action.	Evaluate in FS.	Evaluate in FS.
16	Flashing Ground	Evaluate in FS.	Evaluate in FS.	Evaluate in FS.
17	Propellant Shipping Area	Evaluate in FS.	Evaluate in FS.	Evaluate in FS.
18	Blending Tower Area	No further action.	Evaluate in FS.	Evaluate in FS.
19	Lead Facility	No further action.	Evaluate in FS.	No further action.
20	Rifle Powder Finishing Area	No further action.	Evaluate in FS.	Evaluate in FS.
22	Demolition Landfill	No further action. Landfill has been capped.	No further action. Landfill has been capped.	No further action. Landfill has been capped.
25	Storage Battery/Demolition Debris	Remove batteries and debris from hillside.	Remove batteries and debris from hillside. Evaluate COCs in FS.	Remove batteries and debris from hillside. Evaluate COCs in FS.
CERFA Site	Coke Oven (B6)	No further action.	Evaluate in FS.	Evaluate in FS.
CERFA Site	Downed Utility Poles with Transformers and Transformer Storage Building (PO)	No further action pending approval of the Closure Report for remediated soils.	No further action pending approval of the Closure Report for remediated soils.	No further action pending approval of the Closure Report for remediated soils.
CERFA Site	USTs and Gas Station (US and GS)	No further action	Evaluate in FS.	No further action.
CERFA Site	Fertilizer and Pesticide Storage Building (PS)	Evaluate in FS.	Evaluate in FS.	Evaluate in FS.

[a] Recommendations are based on ecoCOCs with HQ >1.

[b] Risk assessment results show COCs. However, site has been remediated.

Table 8-2. Recommendations for Sediment Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area No.	Study Area	Protection of Human Health		Protection of Ecological Resources[a]
		Likely Land Use (Industrial and Construction)	Most Conservative Land Use (Residential)	
5	Red Water Storage Basin	No further action.	No further action.	No further action.
9	Aniline Sludge Basin – Sediment	No further action.	Evaluate sediment in FS.	Evaluate sediment in FS.
9	Aniline Sludge Basin – Tar	No further action.	No further action.	No further action.
9	Aniline Sludge Basin – Sediments Beneath Tar	No further action.	No further action.	No further action.
16	Flashing Ground	No further action.	No further action.	No further action.
21	Red Water Ditch	No further action.	No further action.	Evaluate sediment in FS.
26	Crossover Ditch	No further action.	No further action.	Evaluate sediment in FS.
27	Beaver Pond Drainage System	No further action.	No further action.	Evaluate sediment in FS.
Talladega Creek		No further action.	No further action.	No further action[b].
Coosa River		No further action.	No further action.	No further action[b].

[a] Recommendations are based on ecoCOCs with HQ >1.

[b] Although risk assessment results show COCs, no further action is recommended in this Supplemental RI/FS. This area is being evaluated as part of a separate groundwater investigation.

Table 8-3. Recommendations for Surface Water Alabama Army Ammunition Plant, Childersburg, Alabama

Study Area No.	Study Area	Protection of Human Health		Protection of Ecological Resources[a]
		Likely Land Use (Industrial and Construction)	Most Conservative Land Use (Residential)	
9	Aniline Sludge Basin	No further action.	No further action.	Evaluate in FS.
16	Flashing Ground	No further action.	No further action.	Evaluate in FS.
21	Red Water Ditch	No further action.	Evaluate in FS based on COCs in fish tissue.	Evaluate in FS.
26	Crossover Ditch	No further action.	Evaluate in FS based on COCs in fish tissue.	Evaluate in FS.
27	Beaver Pond Drainage System	No further action.	No further action.	Evaluate in FS.
Talladega Creek		No further action.	No further action.	No further action.
Coosa River		No further action.	No further action.	No further action[b].

[a] Recommendations are based on ecoCOCs with HQ >1.

[b] Although risk assessment results show COCs, no further action is recommended in this Supplemental RI/FS. This area is being evaluated as part of a separate groundwater investigation.

- Soil screening data collected during Phase 1 indicated that extensive explosives contamination is not present in the surface soils. Contamination was limited to an area of 500 feet square and to a depth of 1 foot below land surface (BLS). Laboratory analysis confirmed the presence of 2,4-dinitrotoluene (2,4-DNT) contaminated soil at one location at a concentration of 26,100 µg/g. The area of contaminated soil was remediated.

- Under the likely future land use scenarios (i.e., industrial and construction), human health COCs include arsenic and six polycyclic aromatic hydrocarbons (PAHs) (benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, dibenzo[a,h]anthracene, and indeno[1,2,3-cd]pyrene).

- Under the most conservative land use scenario (i.e., residential), human health COCs include 2,4-dinitrotoluene, four metals (arsenic, hexavalent chromium, iron, and manganese), and six PAHs (benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, dibenzo[a,h]anthracene, and indeno[1,2,3-cd]pyrene).

- Eight metals (aluminum, arsenic, barium, chromium, lead, manganese, vanadium, and zinc) were identified as ecoCOCs (HQ >1). EcoCOCs with HQs >10 included aluminum, chromium, lead, and vanadium. Aluminum was detected in Study Area 2 at among the highest concentrations within Area B and was the primary metal contributor to ecological risk.

Recommendations

- The areas of soil containing the 2,4-DNT and PAH contamination have been remediated.

- For the protection of human health based on the likely land use scenarios (i.e., industrial and construction), the FS should evaluate actions required for the PAHs and the elevated arsenic concentrations in the surface soils.

- For the protection of human health based on the most conservative land use scenario (i.e., residential), the FS should evaluate actions required for 2,4-DNT, PAHs, and the elevated metals concentrations in the surface and subsurface soils.

- For the protection of the environment, the FS should evaluate actions required for elevated metals concentrations in the surface soils.

8.1.2 Study Area 3 – Sanitary Landfill

Soil

- Eighteen metals were detected at concentrations that exceed background.

- Under the likely future land uses (i.e., industrial and construction), no human health COCs were identified.
- Under the most conservative land use scenario (i.e., residential), human health COCs include arsenic, iron, and manganese.
- Four metals were identified as ecoCOCs (HQ >1) (arsenic, cobalt, lead, and vanadium). Vanadium was identified as an ecoCOC with an HQ >10.
- No explosives, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), or pesticides/polychlorinated biphenyls (PCBs) were identified as COCs at this study area.

Recommendations

- For the protection of human health based on the likely land use scenarios (i.e., industrial and construction), no further action is recommended.
- For the protection of human health based on the most conservative land use scenario (i.e., residential), the FS should evaluate actions required for elevated metals concentrations in the surface and subsurface soils.
- For the protection of ecological resources, the FS should evaluate actions required for ecoCOCs in the surface soil.

8.1.3 Study Area 4 – Manhattan Project Area

Soil

- Thirteen metals were detected at concentrations that exceed background.
- Under the future construction land use, lead was identified as a human health COC.
- Under the most conservative land use scenario (i.e., residential), lead was identified as a human health COC.
- Three metals (aluminum, lead, and zinc) were identified as ecoCOCs (HQ >1). Aluminum and lead were ecoCOCs with HQ >10. Aluminum is the primary contributor to ecological risks (HQ >100).
- No explosives, volatile organic compounds (VOCs), or semivolatile organic compounds (SVOCs) were identified as COCs.

Recommendations

- For the protection of human health based on the likely land use scenarios (i.e., industrial and construction), the FS should evaluate actions required for the elevated lead concentrations in the surface soils.
- For the protection of human health based on the most conservative land use scenario (i.e., residential), the FS should evaluate actions required for the elevated lead concentrations in the surface and subsurface soils.
- For protection of ecological resources, the FS should evaluate actions required for ecoCOCs in the surface soils.

8.1.4 Study Area 5 – Red Water Storage Basin

Sediment

- No metals were detected at concentrations that exceeded background in the sediments at Study Area 5. One nontarget explosive compound (cyclotetramethylenetetranitramine [HMX]) was detected in one sediment sample at a concentration of 0.499 μg/g. There is no documented history of HMX use at ALAAP.
- No human health or ecoCOCs were identified.

Recommendation

- No further actions are required for sediments at the Red Water Storage Basin.

8.1.5 Study Area 6 – Southern TNT Manufacturing Area

Soil

- Ten metals were detected in the soils at concentrations that exceed background.
- No human health COCs were identified.
- Lead was identified as an ecoCOC (HQ >1) in surface soil. Lead was not identified as an ecoCOC with an HQ >10.

Recommendation

- This study area has been remediated. Therefore, no further action is required.

8.1.6 Study Area 7 – Northern TNT Manufacturing Area

Soil

- Thirteen metals were detected in soils at concentrations that exceed background.
- Under the likely future land uses (i.e., industrial and construction), no human health COCs were identified.
- Under the most conservative land use (i.e., residential), human health COCs include 2,4,6-trinitrotolune (TNT) and manganese.
- Lead was identified as an ecoCOC (HQ >1) in surface soil. Lead was not identified as an ecoCOC with an HQ >10.

Recommendation

- This study area has been remediated. Therefore, no further action is required.

8.1.7 Study Area 8 – Acid/Organic Manufacturing Area

Soil

- Nineteen metals were detected at concentrations that exceed background.
- Under the future construction land use, nickel was identified as a human health COC.
- Under the most conservative land use (i.e., residential), human health COCs include five metals (arsenic, iron, lead, manganese, and nickel), and five PAHs (benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, dibenzo[a,h]anthracene, and indeno[1,2,3-cd]pyrene).
- Nine metals (aluminum, arsenic, barium, lead, manganese, molybdenum, nickel, vanadium, and zinc) were identified as ecoCOCs (HQ >1). Four metals (aluminum, lead, nickel, and vanadium) were identified as ecoCOCs with HQs >10. The primary contributors to ecological risk are aluminum, lead, and nickel. Aluminum had an HQ >100 and was detected in the western region of the former manufacturing area and the nonmanufacturing portion of Study Area 8.
- Vanadium was detected in the nonmanufacturing portion of Study Area 8, near the Aniline Sludge Basin.
- No explosives or VOCs were identified as COCs.

Test Pits

- Eleven metals were detected at concentrations that exceeded background in the subsurface soil samples collected from the test pits.
- Under the future construction land use, iron in subsurface soil was identified as a human health COC.
- Under the most conservative land use (i.e., residential), the human health COCs in subsurface soil include three metals (antimony, arsenic, and iron).
- Ecological risk assessments were not conducted because all of the soil samples were collected from subsurface depths.

Recommendations

- For the protection of human health based on the likely land use scenarios (i.e., industrial and construction), the FS should evaluate actions required for elevated nickel concentrations in the surface soil and elevated iron concentrations in the subsurface soil.
- For the protection of human health based on the most conservative land use scenario (i.e., residential), the FS should evaluate actions required for elevated metal concentrations in the surface and subsurface soils and elevated PAH concentrations in the surface soil.
- For protection of ecological resources, the FS should evaluate actions required for elevated metal concentrations in the surface soil. No further actions are required for subsurface soil for protection of ecological resources.

8.1.8 Study Area 9 – Aniline Sludge Basin

Sediment

- Eleven metals were detected at concentrations that exceed background. The highest concentrations of metals were detected at the northern end of the basin, suggesting that the source was the inlet to the basin. The presence of metals in the sediments at the Aniline Sludge Basin is consistent with its use as a holding pond for sludges from the Acid/Organic Manufacturing Area.
- Sediment exposures were not evaluated under industrial and construction future land uses. Therefore, no human health COCs were identified for the likely future land use.
- Under the most conservative land use (i.e., residential), iron was identified as a human health COC.

- Seven metals were identified as ecoCOCs (HQ >1), including arsenic, chromium, copper, lead, manganese, nickel, and zinc. Arsenic and copper were ecoCOCs with HQs >10. Four PAHs were identified as ecoCOCs (HQ >1). These PAHs were not ecoCOCs with HQs >10.

- No explosives or VOCs were identified as COCs in the human health or ecological risk assessments.

- An elevated concentration of explosives (1,800 µg/g) was detected in one screening sample collected at a depth of 1 foot BLS at the outlet to the basin. Explosives were not detected in any other screening samples collected from the basin. TNT and 4-amino-2,6-DNT (4-A-2,6-DNT) were detected at concentrations less than 5 µg/g in the confirmatory samples from the basin sediments.

Tar

- Ten metals were detected at concentrations that exceeded background. Three SVOCs were detected in the tar collected from the Aniline Sludge Basin (carbazole, N-Nitrosodiphenylamine, and phenol).

- Exposures to the tar were not evaluated under industrial and construction future land uses. Therefore, no human health COCs were identified for the likely future land use.

- Under the most conservative land use (i.e., residential), iron, lead, and N-nitrosodiphenylamine were identified as human health COCs.

- Exposure to tar was not evaluated in the ecological risk assessment. Therefore, no ecoCOCs were identified.

Sediment Beneath Tar

- Eight metals were detected at concentrations that exceeded background in the sediments collected from beneath the tar at the Aniline Sludge Basin.

- Four SVOCs were detected in the sediments that were sampled from beneath the tar. Three of the SVOCs (carbazole, N-Nitrosodiphenylamine, and phenol) were detected in both the tar and the sediments beneath the tar. Benzoic acid also was detected in the sediments beneath the tar.

- No human health COCs were identified.

- Exposure to subsurface sediments was not evaluated in the ecological risk assessment. Therefore, no ecoCOCs were identified.

Surface Water

- One surface water sample was collected at Study Area 9. Five metals were detected at concentrations that exceeded background in the surface water. Explosives and SVOCs were not detected in the surface water sample.

- Surface water exposures were not evaluated under industrial and construction future land uses. Therefore, no human health COCs were identified for the likely future land use.

- Under the most conservative land use (i.e., residential), no human health COCs were identified.

- Three ecoCOCs (copper, iron, and lead) were identified in the surface water at Study Area 9 with HQs > 1. No ecoCOCs were identified with HQs >10.

- The concentrations of copper, iron, and lead in the surface water sample slightly exceeded the Alabama Department of Environmental Management (ADEM) criteria and National Ambient Water Quality Criteria (NAWQC) for these metals.

Recommendations

- The tar and contaminated sediments beneath the tar have been removed from Study Area 9.

- For the protection of human health based on the likely land use scenarios (i.e., industrial and construction), no further action is required for sediments.

- For the protection of human health based on the most conservative land use scenario (i.e., residential), the FS should evaluate actions required for elevated iron concentrations in sediment.

- For protection of the environment, remediation of sediments should be evaluated in the FS.

- No further actions are required for surface water for the protection of human health.

- Further evaluation in the FS is recommended for surface water based on the ecological risk assessment.

8.1.9 Study Area 10 – Tetryl Manufacturing Area (East)

Soil

- Screening data did not indicate the presence of explosives in surface soils in the eastern half of the study area; this was confirmed by laboratory analysis of soil samples.
- Fifteen metals were detected at concentrations that exceeded background in the surface soils at Study Area 10.
- Under the likely future land uses (i.e., industrial and construction), manganese was identified as a human health COC.
- Under the most conservative land use scenario (i.e., residential), human health COCs include iron and manganese.
- Barium, lead, and manganese were identified as ecoCOCs (HQ >1) in surface soils. No metals were identified as ecoCOCs with HQs >10.
- No SVOCs or VOCs were identified as human health or ecological COCs.

Recommendations

- For the protection of human health based on the likely land use scenarios (i.e., industrial and construction), the FS should evaluate actions required for elevated manganese concentrations in surface soil.
- For the protection of human health based on the most conservative land use scenario (i.e., residential), the FS should evaluate actions required for elevated metals concentrations in surface and subsurface soils.
- For protection of ecological resources, the FS should evaluate actions required for elevated metal concentrations in the surface soil.

8.1.10 Study Area 10 – Tetryl Manufacturing Area (West)

Soil

- The western part of Study Area 10 has been remediated by excavation of tetryl-contaminated soils. The soils were incinerated in an onsite treatment unit. Five explosive compounds were detected in the soils sampled following remediation in the western portion of Study Area 10. Explosives were detected in 7 of 57 surface soil confirmatory samples. Tetryl was detected in 54 of 96 shallow subsurface soil samples (from depths at the bottom of the excavated areas). All tetryl concentrations were below 1,250 µg/g except one sample (2,939 µg/g).

- Lead was the only metal analyzed in soil samples that were collected after the remediation at Study Area 10–West. Lead was detected in all 49 surface soil and 103 shallow subsurface soil samples collected for confirmatory analysis. The maximum lead concentration detected was 2,000 µg/g in the surface soils and 400 µg/g in the subsurface soils.

- Under the likely future land uses (i.e., industrial and construction), no human health COCs were identified.

- Under the most conservative land use (i.e., residential), lead was identified as a human health COC.

- Lead was identified as an ecoCOC with an HQ >10.

Recommendations

- For the protection of human health based on the likely land use scenarios (i.e., industrial and construction), no further action is recommended.

- For the protection of human health based on the most conservative land use scenario (i.e., residential), the FS should evaluate actions required for elevated lead concentrations in the surface soil.

- For the protection of ecological resources, the presence of lead in surface soil should be evaluated in the FS.

8.1.11 Study Area 16 – Flashing Ground

Soil

- Study Area 16 has been remediated by excavation of explosives- and lead-contaminated soils. The soils were treated by incineration (explosives and lead) and stabilization (lead only). Some areas of lead-contaminated soils remain at concentrations that exceeded background. The maximum lead concentration detected in the surface soils was 5,400 µg/g.

- Eighteen metals were identified as chemicals exceeding background (CEBs) in the soils sampled from Study Area 16.

- Under the likely future land use scenarios (i.e., industrial and construction), lead was identified as a human health COC.

- Under the most conservative land use scenario (i.e., residential), human health COCs include TNT, three metals (arsenic, iron, and lead), and five PAHs (benzo[a]anthracene,

benzo[a]pyrene, benzo[b]fluoranthene, dibenzo[a,h]anthracene, and indeno[1,2,3-cd]pyrene).

- Ten metals (aluminum, arsenic, barium, cadmium, copper, lead, mercury, nickel, vanadium, and zinc) were identified as ecoCOCs (HQ >1). Aluminum, cadmium, copper, lead, and vanadium were identified as ecoCOCs with HQs >10.

Sediment

- One sediment sample was collected from a drainage area north of Study Area 16. Three metals were detected at concentrations that exceeded background.
- Explosives were not detected in the sediment sample collected north of Study Area 16.
- Sediment exposures were not evaluated under industrial and construction future land uses. Therefore, no human health COCs were identified for the likely future land use.
- Under the most conservative land use (i.e., residential), no human health COCs were identified.
- No ecoCOCs were identified.

Surface Water

- Four metals were detected in a surface water sample at concentrations above background.
- Two explosive compounds, TNT (0.733 µg/L) and 2,4-DNT (4.5 µg/L), were detected in the surface water sample collected north of the Flashing Ground.
- No SVOCs, VOCs, or explosives were identified as COCs.
- Surface water exposures were not evaluated under industrial and construction future land uses. Therefore, no human health COCs were identified for the likely future land use.
- Under the most conservative land use (i.e., residential), no human health COCs were identified.
- Cobalt, iron, and manganese were identified as ecoCOCs with HQs >10.
- Iron was detected in the surface water sample collected at Study Area 16 at a concentration greater than the ADEM criteria and chronic NAWQC.

Recommendations

- For the protection of human health based on the likely land use scenarios (i.e., industrial and construction), the FS should evaluate actions required for elevated lead concentrations in the surface soil.

- For the protection of human health based on the most conservative land use scenario (i.e., residential), the FS should evaluate actions required for elevated TNT, metals, and PAH concentrations in the soil.

- For the protection of ecological resources, soil remedial actions should be evaluated in the FS.

- No further actions are required for the area of sediment sampled north of the Flashing Ground.

- No further actions are required for the surface water for the protection of human health.

- Based on the ecological risk assessment, remedial action alternatives for the surface water should be evaluated in the FS.

8.1.12 Study Area 17 -- Propellant Shipping Area

Soil

- Good correlation was observed between the field screening data for explosives and laboratory confirmatory data collected during the Phase 1 Supplemental RI. These results indicated that explosives contamination of the surface soils was limited in areal extent and concentrated in localized hot spots. The localized hot spots subsequently were excavated and treated by onsite incineration.

- Fifteen metals were detected at concentrations that exceed background.

- Under the likely future land uses (i.e., industrial and construction), manganese was identified as a human health COC.

- Under the most conservative land use scenario (i.e., residential), human health COCs include arsenic, iron, and manganese.

- Aluminum, arsenic, barium, and manganese were identified as ecoCOCs (HQ >1). Aluminum was identified as an ecoCOC with an HQ >10. Aluminum is the major contributor to ecological risk with an HQ >100.

- No VOCs or SVOCs were identified as COCs.

Recommendation

- For the protection of human health based on the likely land use scenarios (i.e., industrial and construction), the FS should evaluate actions required for elevated manganese concentrations in surface soil.

- For the protection of human health based on the most conservative land use scenario (i.e., residential), the FS should evaluate actions required for elevated metals concentrations in surface and subsurface soils.

- For protection of ecological resources, remedial actions should be evaluated in the FS for the presence of ecoCOCs in surface soil.

8.1.13 Study Area 18 – Blending Tower Area

Soil

- Screening data indicate that low concentrations (<33 µg/g) of explosives are present in isolated areas. One soil sample collected for laboratory confirmatory analysis contained 2,4-DNT at a low concentration (0.069 µg/g).

- Nine metals were detected in the soils at concentrations that exceeded background.

- No explosives, SVOCs, or VOCs were identified as COCs in either the human health or ecological risk assessment.

- Under the likely future land uses (i.e., industrial and construction), no human health COCs were identified.

- Under the most conservative land use scenario (i.e., residential), human health COCs include arsenic, iron, and manganese.

- Arsenic, chromium, manganese, and vanadium were identified as ecoCOCs (HQ >1). Chromium and vanadium were identified as ecoCOCs with HQs >10.

Recommendations

- For the protection of human health based on the likely land use scenarios (i.e., industrial and construction), no further action is recommended.

- For the protection of human health based on the most conservative land use scenario (i.e., residential), the FS should evaluate actions required for elevated metals concentrations in the surface and subsurface soils.

- For the protection of ecological resources, the presence of ecoCOCs in surface soil should be evaluated in the FS.

8.1.14 Study Area 19 -- Lead Facility

Soil

- Screening data from Phase 1 indicated that there were high (up to 24,000 µg/g) concentrations of lead distributed in the surface soils at this study area. Based on the Phase 1 results, lead-contaminated soils were excavated and stabilized using an onsite pugmill.
- Five metals currently are present in the soils at concentrations above background.
- No explosives, SVOCs, or VOCs were identified as COCs.
- Under the likely future land uses (i.e., industrial and construction), no human health COCs were identified.
- Under the most conservative land use scenario (i.e., residential), arsenic was identified as a human health COC.
- No COCs were identified in the ecological risk assessment.

Recommendation

- The lead-contaminated soils have been removed from this study area.
- For the protection of human health based on the likely land use scenarios (i.e., industrial and construction), no further action is recommended.
- For the protection of human health based on the most conservative land use scenario (i.e., residential), the FS should evaluate actions required for elevated arsenic concentrations in the subsurface soil.
- For the protection of ecological resources, no further actions are required.

8.1.15 Study Area 20 -- Rifle Powder Finishing Area

Soil

- Field screening data for surface soils indicate that explosives were not present above the detection limit of 2.5 µg/g. Field screening of subsurface soils detected explosives at a concentration of 13 µg/g. Low concentrations (less than 1.13 µg/g) of 2,4-DNT were confirmed in surface and subsurface soils through confirmatory analysis.

- Fifteen metals were detected at concentrations that exceed background.
- No explosives, SVOCs, or VOCs were identified as COCs.
- Under the likely future land uses (i.e., industrial and construction), no human health COCs were identified.
- Under the most conservative land use scenario (i.e., residential), iron was identified as a human health COC.
- Aluminum, arsenic, barium, and chromium were identified as ecoCOCs (HQ >1). Aluminum and chromium were identified as ecoCOCs with HQs >10.

Recommendations

- For the protection of human health based on the likely land use scenarios (i.e., industrial and construction), no further action is recommended.
- For the protection of human health based on the most conservative land use scenario (i.e., residential), the FS should evaluate actions required for elevated iron concentrations in the subsurface soil.
- Based on the ecological risk assessment, remedial actions should be evaluated in the FS.

8.1.16 Study Area 21 – Red Water Ditch

Sediment

- Seventeen metals were detected in the sediments at concentrations that exceed background.
- Aluminum, arsenic, barium, lead, mercury, molybdenum, and vanadium concentrations are highest in the northern tributary of the Red Water Ditch and may be associated with either the tetryl or acid/organic manufacturing areas. The lower portions of this tributary have been remediated for explosives.
- Sediment exposures were not evaluated under industrial and construction future land uses. Therefore, no human health COCs were identified for the likely future land use.
- Under the most conservative land use (i.e., residential), no human health COCs were identified.
- Five metals (arsenic, chromium, copper, lead, and manganese) were identified as ecoCOCs (HQ >1). None of these metals was identified as an ecoCOC with an HQ >10.

- Pyrene and acetone were identified as ecoCOCs with HQs >1. They were not identified as ecoCOCs with HQs >10.

- Screening data indicated that low concentrations of explosives are present; only one sample of 256 collected samples contained explosives exceeding 100 μg/g. This sample was collected in the portion of the tributary that previously had been remediated. Laboratory analyses of sediment samples collected in the unremediated portions of the ditch confirmed that explosives were not present in the surface sediments above concentrations of 4 μg/g.

Surface Water

- Nine metals were detected at concentrations above background in surface water.

- No explosives or SVOCs were detected in the surface water sampled at Study Area 21.

- Surface water exposures were not evaluated under industrial and construction future land uses. Therefore, no human health COCs were identified for the likely future land use.

- Under the most conservative land use (i.e., residential), no human health COCs were identified in the surface water. However, arsenic and Aroclor 1254 were identified as COCs in fish tissue.

- Aluminum, barium, iron, and manganese were identified as ecoCOCs with HQs >1. Aluminum, barium, and manganese were identified as ecoCOCs with HQs > 10. Carbon disulfide was identified as an ecoCOC with an HQ >1 but was not identified as an ecoCOC with an HQ >10.

- Surface water collected from Study Area 21 contained iron and lead at concentrations that exceeded the ADEM surface water criteria. Exceedances of the chronic NAWQC were confirmed in surface water for aluminum, iron, and lead.

Recommendations

- For the protection of human health based on the likely land use scenarios (i.e., industrial and construction), no further action is recommended.

- For the protection of human health based on the most conservative land use scenario (i.e., residential), no further actions are required for the sediment. However, remedial action alternatives for the surface water should be evaluated in the FS based on COCs identified in fish tissue.

- For protection of ecological resources, remedial action alternatives for the sediment and surface water should be evaluated in the FS.

8.1.17 Study Area 22 – Demolition Landfill

Soil

- Eighteen metals were detected in soils at concentrations that exceed background.

- Lead contamination of the soils extends to depths of 20 feet BLS at this study area. Lead concentrations (up to 15,000 µg/g) were among the highest detected in subsurface soils in Area B. At more shallow locations (1 to 3 feet BLS), a variety of PAHs were detected at high concentrations.

- Under the likely future land use scenarios (i.e., industrial and construction), human health COCs include arsenic, lead, and six PAHs (benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, dibenzo[a,h]anthracene, and indeno[1,2,3-cd]pyrene).

- Under the most conservative land use scenario (i.e., residential), human health COCs include five metals (arsenic, hexavalent chromium, iron, lead, and manganese), and eight PAHs (benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[g,h,i]perylene, benzo[k]fluoranthene, chrysene, dibenzo[a,h]anthracene, and indeno[1,2,3-cd]pyrene).

- Four metals (lead, mercury, nickel, and zinc) were identified as ecoCOCs (HQ >1). Lead and zinc were ecoCOCs with HQs >10.

- Soil contamination at this study area is attributed to burial of construction debris following the burning of buildings within Area B.

Recommendation

- Following completion of the Phase 1 Supplemental RI, a recommendation was made to cap the landfill. The landfill has been capped; therefore, no further actions are required other than periodic maintenance of the engineered cap.

8.1.18 Study Area 25 – Storage Battery/Demolition Debris

Soil

- Eighteen metals were detected at concentrations above background at Study Area 25.
- Under the likely future land uses (i.e., industrial and construction), no human health COCs were identified.
- Under the most conservative land use scenario (i.e., residential), human health COCs include iron and manganese.
- Arsenic, chromium, vanadium, and zinc were identified as ecoCOCs (HQ >1); chromium and vanadium were identified as ecoCOCs with HQs >10.

Recommendations

- The batteries and debris that remain at this study area should be removed.
- For the protection of human health based on the likely land use scenarios (i.e., industrial and construction), no further action is recommended.
- For the protection of human health based on the most conservative land use scenario (i.e., residential), the FS should evaluate actions required for elevated metals concentrations in the surface and subsurface soils.
- For protection of ecological resources, the FS should evaluate actions for ecoCOCs in surface soil.

8.1.19 Study Area 26 – Crossover Ditch

Sediment

- Twenty-one metals were detected at concentrations that exceeded background.
- The highest concentrations of arsenic in sediments within Area B were detected in the southern tributary of the Crossover Ditch that runs east of Study Area 2 and originates offsite, south of the Area B boundary.

- No significant concentrations of explosives (maximum of 22.1 μg/g) were detected in any of the transects sampled and screened from the Crossover Ditch. This was verified through laboratory confirmatory analysis of samples collected at nine locations across this study area.

- Sediment exposures were not evaluated under industrial and construction future land uses. Therefore, no human health COCs were identified for the likely future land use.

- Under the most conservative land use (i.e., residential), no human health COCs were identified.

- Three metals (arsenic, chromium, and manganese) were identified as ecoCOCs with HQs >1. No metals were identified as ecoCOCs with HQs >10. Acetone was identified as an ecoCOC with an HQ >1.

- No explosives or SVOCs were identified as COCs at the Crossover Ditch.

Surface Water

- Seven metals were detected in surface water at concentrations above background.

- Surface water exposures were not evaluated under industrial and construction future land uses. Therefore, no human health COCs were identified for the likely future land use.

- Under the most conservative land use (i.e., residential), no human health COCs were identified in the surface water. However, mercury was identified as a COC in fish tissue.

- Aluminum, barium, iron, and manganese were identified as ecoCOCs (HQ >1) for aquatic biota. Barium and manganese were ecoCOCs with HQs >10.

- No SVOCs, VOCs, or explosives were identified as COCs.

- Iron was detected in the surface water at concentrations that exceeded the ADEM surface water criteria.

Recommendations

- For the protection of human health based on the likely land use scenarios (i.e., industrial and construction), no further action is recommended.

- For the protection of human health based on the most conservative land use scenario (i.e., residential), no further actions are required for the sediment. However, remedial

action alternatives for the surface water should be evaluated in the FS based on mercury identified as a COC in fish tissue.

- For protection of ecological resources, remedial action alternatives for the sediment and surface water should be evaluated in the FS.

8.1.20 Study Area 27 – Beaver Pond Drainage System

Sediment

- Fifteen metals were detected at concentrations that exceeded background.
- Sediment exposures were not evaluated under industrial and construction future land uses. Therefore, no human health COCs were identified for the likely future land use.
- Under the most conservative land use (i.e., residential), no human health COCs were identified.
- Five metals, including arsenic, chromium, lead, manganese, and zinc, were identified as ecoCOCs with HQs >1. No ecoCOCs were identified with HQs >10.
- Explosives screening data showed limited detections of explosives (maximum of 41.8 µg/g). These results were verified through laboratory confirmatory analysis of sediment samples; target explosives were not detected in any of the sediment samples collected. One nontarget explosive (HMX) was detected at a concentration of 0.215 µg/g in one sediment sample collected from this study area.

Surface Water

- Seven metals were detected in surface water at concentrations that exceeded background.
- Eight explosives were detected in surface water sampled from a location between the east and west Beaver Ponds. The explosives included 2,4-DNT, 2,6-DNT, TNT, and explosive breakdown products.
- Surface water exposures were not evaluated under industrial and construction future land uses. Therefore, no human health COCs were identified for the likely future land use.
- Under the most conservative land use (i.e., residential), no human health COCs were identified in the surface water.

- Aluminum, barium, iron, and manganese were identified as ecoCOCs with HQs >1 for aquatic biota. Barium and manganese were identified as ecoCOCs with HQs >10.

- Iron and lead were detected in the surface water at concentrations that exceeded the ADEM surface water criteria.

Recommendations

- For the protection of human health based on the likely land use scenarios (i.e., industrial and construction), no further action is recommended.

- For the protection of human health based on the most conservative land use scenario (i.e., residential), no further action is recommended.

- For protection of ecological resources, remedial action alternatives for the sediment and surface water should be evaluated in the FS.

8.1.21 Talladega Creek

Sediment

- Eight metals were detected at concentrations exceeding background.

- Sediment exposures were not evaluated under industrial and construction future land uses. Therefore, no human health COCs were identified for the likely future land use.

- Under the most conservative land use (i.e., residential), no human health COCs were identified in the sediment.

- Arsenic, lead, and manganese were identified as ecoCOCs with HQs >1. No ecoCOCs were identified with HQs >10.

- Screening results indicate that significant explosives contamination of the Talladega Creek sediments is not present; these results were verified through laboratory analyses of sediment samples. The maximum concentrations of three CEB metals, two explosives, and toluene were detected in the tributary draining Study Areas 16 and 19.

Surface Water

- Metals concentrations in surface water samples from Talladega Creek did not exceed background.

- No explosives, VOCs, or pesticides were detected in the surface water.

- Surface water exposures were not evaluated under industrial and construction future land uses. Therefore, no human health COCs were identified for the likely future land use.
- Under the most conservative land use (i.e., residential), no human health COCs were identified in the surface water.
- No ecoCOCs were identified for the Talladega Creek surface water.

Recommendations

- For the protection of human health based on the likely land use scenarios (i.e., industrial and construction), no further action is recommended.
- For the protection of human health based on the most conservative land use scenario (i.e., residential), no further action is recommended.
- For protection of ecological resources, no further action is recommended for the surface water.
- The ecological risk assessment results suggest that evaluation of the sediment COCs should be conducted in an FS. However, since the sediments in Talladega Creek are being evaluated as part of a separate groundwater investigation, no further action is recommended in this Supplemental RI/FS.

8.1.22 Coosa River

Sediment

- Eleven metals were detected at concentrations exceeding background.
- Sediment exposures were not evaluated under industrial and construction future land uses. Therefore, no human health COCs were identified for the likely future land use.
- Under the most conservative land use (i.e., residential), no human health COCs were identified in the sediment.
- Mercury was identified as an ecoCOC with an HQ >1. Mercury was not identified as an ecoCOC with an HQ >10.
- Screening results indicate that significant explosives contamination of the Coosa River sediments is not present. These results were verified by laboratory analyses of sediment samples.

Surface Water

- Three metals (aluminum, arsenic, and iron) were detected at concentrations that exceeded background.
- Explosives were not detected in the surface water samples collected from the Coosa River.
- Surface water exposures were not evaluated under industrial and construction future land uses. Therefore, no human health COCs were identified for the likely future land use.
- Under the most conservative land use (i.e., residential), no human health COCs were identified in the surface water.
- Aluminum was identified as an ecoCOC with an HQ >1. The HQ for aluminum did not exceed 10 in the Coosa River samples.

Recommendation

- For the protection of human health based on the likely land use scenarios (i.e., industrial and construction), no further action is recommended.
- For the protection of human health based on the most conservative land use scenario (i.e., residential), no further action is recommended.
- The ecological risk assessment results suggest that evaluation of the sediment and surface water COCs should be conducted in an FS. However, since the Coosa River surface water and sediment are being evaluated as part of a separate groundwater investigation, no further action is recommended in this Supplemental RI/FS.

8.1.23 Building 6 – Coke Oven

Soil

- Seventeen metals were detected at concentrations that exceeded background.
- Under the likely future land uses (i.e., industrial and construction), no human health COCs were identified.
- Under the most conservative land use scenario (i.e., residential), human health COCs include arsenic, iron, and manganese.

- Aluminum, arsenic, lead, and zinc were identified as ecoCOCs with HQs >1. Aluminum was identified as an ecoCOC with an HQ >10.

- Explosives were not detected in screening samples collected from surface soils covering the area; subsurface soils contained low concentrations of explosives (<5 μg/g) when screened in the field. One nontarget explosive compound (HMX) was detected in a confirmatory surface soil sample at a concentration of 0.518 μg/g. The source of HMX in the soils is unknown. Explosives were not identified as human health or ecological COCs.

Recommendations

- For the protection of human health based on the likely land use scenarios (i.e., industrial and construction), no further action is recommended.

- For the protection of human health based on the most conservative land use scenario (i.e., residential), the FS should evaluate actions required for elevated metals concentrations in the surface and subsurface soils.

- For the protection of ecological resources, the presence of ecoCOCs in surface soil should be evaluated in the FS.

8.1.24 Downed Utility Poles with Transformers and Transformer Buildings

Soil

- Eleven metals were detected in subsurface soils at concentrations that exceed background.

- Under the likely future land uses (i.e., industrial and construction), Aroclors 1248, 1254, and 1260 were identified as a human health COCs.

- Under the most conservative land use scenario (i.e., residential), Aroclors 1248, 1254, and 1260 were identified as a human health COCs.

- Two PCBs (Aroclors 1248 and 1254) were identified as ecoCOCs with HQs >1. No ecoCOCs with HQs > 10 were identified.

- Screening and confirmatory samples fully characterized the extent of contamination from the transformer poles. The contaminated area is limited to surface soils in the vicinity of the two downed transformers. Although the ecological HQs are <10, PCBs are persistent and bioaccumulate.

Recommendation

- Following completion of the Phase 1 Supplemental RI, a recommendation was made to remediate the PCB-contaminated soils. Excavation and disposal of the soils was conducted and a Closure Report is pending. Therefore, no further actions are required pending approval of the Closure Report.

8.1.25 Underground Storage Tanks and Gas Station

Soil

- Fourteen metals were detected at concentrations that exceed background.
- Under the likely future land uses (i.e., industrial and construction), no human health COCs were identified.
- Under the most conservative land use scenario (i.e., residential), human health COCs include iron and manganese.
- PAHs were detected at one UST location (SS-US-004) at a depth of 5 feet BLS. None of the PAHs was identified as a human health COC.
- An ecological risk assessment was not conducted because all of the soil samples were collected from depths of 1 foot BLS or deeper.

Recommendation

- For the protection of human health based on the likely land use scenarios (i.e., industrial and construction), no further action is recommended.
- For the protection of human health based on the most conservative land use scenario (i.e., residential), the FS should evaluate actions required for elevated metals concentrations in the subsurface soil.
- For the protection of ecological resources, no further action is required.

8.1.26 Building 223B – Fertilizer and Pesticide Storage Building

Soil

- Eighteen metals, nitrate, and phosphate were detected at concentrations that exceed background in soils.
- Under the likely future land uses (i.e., industrial and construction), iron was identified as a human health COC.

- Under the most conservative land use scenario (i.e., residential), iron and manganese were identified as human health COCs.

- Six metals (aluminum, arsenic, cadmium, chromium, lead, and zinc) were identified as ecoCOCs with HQs >1. Aluminum and chromium were ecoCOCs with HQs >10.

- Pesticides were not detected in surface or subsurface soils around the former storage building. Adequate samples were collected in the vicinity of the building to conclude that the soils around the building are not currently contaminated with pesticides.

Recommendations

- For the protection of human health based on the likely land use scenarios (i.e., industrial and construction), the FS should evaluate actions required for elevated iron concentrations in subsurface soil.

- For the protection of human health based on the most conservative land use scenario (i.e., residential), the FS should evaluate actions required for elevated metals concentrations in surface and subsurface soils.

- For protection of ecological resources, the FS should evaluate actions required for elevated metal concentrations in the surface soil.

8.2 AREA B SUMMARY AND CONCLUSIONS

The previous section presented the findings of the RI report as they relate to the investigation conducted at each study area. The following section is a broader overview of the observed condition of the environmental media investigated at Area B. The discussion focuses on findings for groundwater, soil, sediment, and surface water.

8.2.1 Groundwater

Groundwater underlying ALAAP flows through relict fractures, joints, voids, and bedding in karst limestone and dolomite residuum and weathered bedrock. Groundwater level records indicate that precipitation infiltrates rapidly to the water table across the installation with concurrent water level changes observed in both soil and bedrock wells. These results confirm that a well-developed macropore system of relict joints, fractures, voids, and bedding occurs in the residuum and that Area B is a recharge area for the underlying aquifer. Measured aquifer hydraulic conductivity beneath the installation ranges across eight orders of magnitude from 7.6×10^{-1} to 6.28×10^{-8} cm/sec.

Groundwater movement occurs predominantly to the northwest toward the Coosa River across the industrial portion of Area B. A groundwater divide exists, extending to the northeast

from the southeastern corner of Area B. Available site information indicates that groundwater discharge is to the Coosa River, although substantial preferential subsurface flow paths are documented within 10 miles of ALAAP. Localized redirection of groundwater occurs in the topographically complex portion of Area B east of the groundwater divide in the vicinity of Study Areas 16 and 19 (Flashing Ground and Lead Facility).

The groundwater underlying Area B contains frequently detected organic and inorganic constituents (i.e., explosives and metals) that are attributable to previous activities on ALAAP. Elevated concentrations of nitroaromatic constituents, including 2,4-DNT, 2,6-dinitrotoluene (2,6-DNT), and TNT occurs in the southern portion of Area B between Study Areas 17 and 18 (Propellant Shipping Area and Blending Tower Area) and extending north toward Study Area 6 (Southern TNT Manufacturing Area). Another area of groundwater contamination occurs in the southwestern corner of Area B and is associated with elevated concentrations of 2,4-DNT and TNT. These wells are downgradient from the former smokeless powder manufacturing area at the Alliance Coosa Pines facility (formerly Kimberly-Clark Corporation).

Groundwater containing nitroaromatic compounds also is found at isolated well locations in Study Areas 7, 8, and 10 (Northern TNT Manufacturing Area, Acid/Organic Manufacturing Area, and Tetryl Manufacturing Area). Due to preferential flow paths in the karst aquifer, some of these areas may reflect downgradient "slugs" of the larger contaminant areas or may be related to other localized contaminant sources across the installation.

Additional nitroaromatic compounds detected in the groundwater at Area B include 1,3,5-trinitrobenzene (1,3,5-TNB), 1,3-dinitrobenzene (1,3-DNB), nitrobenzene, and isomers of nitrotoluene. The nitroaromatic breakdown products 2-A-4,6-DNT and 4-A-2,6-DNT also were detected. Nitroaromatic compounds and lead were detected in bedrock wells. A precise source for the explosives is not currently known.

Trace concentrations of VOCs and SVOCs were detected during groundwater analyses, including 1,1,1-trichloroethane (1,1,1-TCA), trichloroethene (TCE), toluene, phenol, PCP, carbon tetrachloride, chloroform, and PAHs. Several concentrations of organic chemicals exceed MCLs, including carbon tetrachloride, PCP, B2EHP, and vinyl chloride.

The spatial distribution of lead concentrations (1.26 to 64,600 μg/L) in the groundwater at Area B was similar to the observed patterns for the nitroaromatic compounds, suggesting a common source area. Lead concentrations in Area B exceed the EPA action level (15 μg/L at the tap) for lead in groundwater. Arsenic concentrations in Area B groundwater did not correspond with other detected organic or inorganic compounds and exceeded the EPA MCL of 50 μg/L at well D-7B.

In the area east of the groundwater divide, the groundwater in the vicinity of Study Areas 16 and 19 (Flashing Ground and Lead Facility) contains nitroaromatic compounds (2,4-DNT, TNT, and 2,6-DNT), metals, VOCs (acetone, toluene, 1,1,1-TCA, and xylene), and a variety of SVOCs.

The groundwater beneath the main industrial portion of Area B contains concentrations of nitroaromatics and metals that would result in risks exceeding EPA targets if the untreated groundwater were used for household purposes. Metals (arsenic, beryllium, lead, and nickel) and organics (carbon tetrachloride, PCP, B2EHP, and vinyl chloride) were detected at concentrations that exceed the MCLs. In the human health risk assessment, groundwater exposures were not considered to be likely under the industrial or construction land use scenarios. For this reason, groundwater exposures were not evaluated under these land uses. Drinking water for Area B currently is supplied by the county water treatment plant, which would likely continue under future industrial or construction land use. However, the baseline human health risk assessment indicates that the risks to hypothetical residential users of the groundwater exceed the risk-based limits established in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). **Table 8-4** presents the COCs identified in groundwater based on exceedance of human health risk targets and based on exceedance of ARARs. Exposure to groundwater for the ALAAP ecological receptors was not considered significant and was not evaluated quantitatively in the ecological risk assessment.

Because of the elevated concentrations of nitroaromatic compounds and lead in the groundwater within Area B, additional investigations are underway to determine the extent of contaminant migration, the potential for risks to offsite receptors, and the feasibility of groundwater remediation. A separate report with recommendations addressing these issues relative to the groundwater contamination will be prepared at the conclusion of the ongoing investigations.

8.2.2 Soils

Soil samples were collected at locations where field-screening data indicated the presence of explosives or lead. Soil boring locations were used to determine the vertical extent of contamination in the subsurface.

Results from Phase 1 of the Supplemental RI indicate that 2,4-DNT was the predominant explosive present in soils at ALAAP. However, since the initial phase (Phase 1) of sampling at ALAAP, an extensive amount of remediation for explosives and lead contamination has been conducted by Roy F. Weston and Environmental Chemical Corporation (ECC). Confirmatory sampling results from these excavations have been combined with the Supplemental RI sampling results and used in the risk assessments for ALAAP – Area B. The resulting risk assessments show that explosives are not human health COCs for the likely future land uses (i.e., industrial and construction) and are not ecoCOCs. Explosives are human health COCs for the most conservative land use (i.e., residential) at Study Area 2 (Smokeless Powder Facility), Study Area 7 (Northern TNT Manufacturing Area), and Study Area 16 (Flashing Ground). Remediation of explosives-contaminated soils was sufficient to reduce risks to acceptable levels for human receptors for the most likely future land use and for ecological receptors. **Table 8-5** presents the COCs identified in soils at ALAAP – Area B for the most conservative land use and **Table 8-6** presents the COCs identified in soils for the most likely land use.

Table 8-4. COCs in Groundwater
Alabama Army Ammunition Plant, Childersburg, Alabama

Constituent in Groundwater	Groundwater Data Aggregate			
	Area 16 and 19	Main Industrial Area	Blending/ Shipping Area	Smokeless Powder Area
Inorganics				
Antimony			■	
Arsenic		■	■	■
Beryllium		▒		
Iron	■	■		■
Lead	▒	■	■	■
Manganese	■	■	■	■
Nickel		▒		▒
Thallium		■		■
Organics				
2,4,6-Trinitrotoluene	■	■	■	■
2,4-Dinitrotoluene	■	■	■	■
2,6-Dinitrotoluene	■	■	■	■
2-amino-4,6-dinitrotoluene	■	■	■	■
4-amino-2,6-dinitrotoluene	■	■	■	
Benzo(a)pyrene		■		
Benzo(b)fluoranthene		■		
bis(2-ethylhexyl)phthalate	■	■	▒	■
Carbon tetrachloride		▒		
Nitrobenzene		■		
Pentachlorophenol	■	■		
RDX	■	■		
Vinyl chloride		■		

COCs are the chemicals of concern identified in the human health assessment.
All COCs for groundwater are for human exposures under an unlikely land use (residential).
Designators are as follows:

■ COC for humans
▒ COC based on ARAR
■ COC for humans and ARAR

Table 8-5. COCs in Soil for the Most Conservative Land Use
Alabama Army Ammunition Plant, Childersburg, Alabama

	Study Area																				
Constituent in Soil	**2**	**3**	**4**	**6**	**7**	**8**	**8A**	**10E**	**10W**	**16**	**17**	**18**	**19**	**20**	**22**	**25**	**B6**	**PO**	**US**	**GS**	**PS**
Inorganics																					
Aluminum																					
Antimony							■														
Arsenic	■	■				■	■			■	■	■	■		■		■				
Barium																					
Cadmium																					
Chromium	■														■						
Cobalt																					
Copper																					
Iron	■	■				■	■	■		■	■	■		■	■	■	■		■		■
Lead			■			■			■	■					■						
Manganese	■	■			■	■		■			■	■			■	■	■		■		■
Mercury																					
Molybdenum																					
Nickel						■															
Vanadium																					
Zinc																					
Organics																					
2,4,6-Trinitrotoluene					■					■											
2,4-Dinitrotoluene	■																				
Aroclor-1248																		■			
Aroclor-1254																		■			
Aroclor-1260																		■			
Benzo(a)anthracene	■					■				■					■						
Benzo(a)pyrene	■					■				■					■						
Benzo(b)fluoranthene	■					■				■					■						
Benzo(g,h,i)perylene															■						
Benzo(k)fluoranthene	■														■						
Chrysene															■						
Dibenzo(a,h)anthracene	■					■				■					■						
Indeno(1,2,3-cd)pyrene	■					■				■					■						

COCs are the chemicals of concern identified in the human health and ecological risk assessment.
The most conservative land use is residential.
Designators are as follows:

■ COC for humans
□ COC for ecological receptors
■ COC for both human and ecological receptors

B6 - Building 6 - Coke Oven
PO - Transformer Storage Building and Utility Poles
US - Underground Storage Tanks

GS - Gas Station
PS - Fertilizer and Pesticide Storage

Table 8-6. COCs in Soil for the Likely Land Use
Alabama Army Ammunition Plant, Childersburg, Alabama

	Study Area																				
Constituent in Soil	**2**	**3**	**4**	**6**	**7**	**8**	**8A**	**10E**	**10W**	**16**	**17**	**18**	**19**	**20**	**22**	**25**	**B6**	**PO**	**US**	**GS**	**PS**
Inorganics																					
Aluminum																					
Arsenic	■														■						
Barium																					
Cadmium																					
Chromium																					
Cobalt																					
Copper																					
Iron							■														■
Lead			■							■					■						
Manganese								■			■										
Mercury																					
Molybdenum																					
Nickel						■															
Vanadium																					
Zinc																					
Organics																					
Aroclor-1248																		■			
Aroclor-1254																		■			
Aroclor-1260																		■			
Benzo(a)anthracene	■														■						
Benzo(a)pyrene	■														■						
Benzo(b)fluoranthene	■														■						
Benzo(g,h,i)perylene																					
Benzo(k)fluoranthene	■														■						
Dibenzo(a,h)anthracene	■														■						
Indeno(1,2,3-cd)pyrene	■														■						

COCs are the chemicals of concern identified in the human health and ecological risk assessment.
Likely land use is industrial/construction.
Designators are as follows:

■ COC for humans
□ COC for ecological receptors
■ COC for both human and ecological receptors

B6 - Building 6 - Coke Oven
PO - Transformer Storage Building and Utility Poles
US - Underground Storage Tanks

GS - Gas Station
PS - Fertilizer and Pesticide Storage

The results from the Supplemental RI for also indicate that lead is a human health COC in soils for both the most likely future land use (i.e., industrial and construction) and the most conservative land use (i.e., residential). Lead was identified as a human health COC for the most likely land use (i.e., industrial and construction) at Study Area 4 (Manhattan Project Area), Study Area 16 (Flashing Ground), and Study Area 22 (Demolition Landfill). Lead was identified as a human health COC for the most conservative land use (i.e., residential) at Study Area 8 (Acid/Organic Manufacturing Area) and Study Area 10 – West (Tetryl Manufacturing Area), in addition to the study areas listed above. A variety of other metals were identified as COCs in the soils throughout the ALAAP – Area B study areas and are summarized on Tables 8-5 and 8-6.

Human health risk estimates for Study Area 16 (Flashing Ground) incorporated results from the Phase 1 Supplemental RI and excavation data from Roy F. Weston and ECC. The resulting risk assessments show that several areas of soil contamination remain in Study Area 16 where lead was identified as a COC for the most likely future land use. Arsenic, iron, lead, and a variety of PAHs and SVOCs were identified at Study Area 16 as COCs for the most conservative land use.

Based on the Phase 1 Supplemental RI and the recommendations presented in the Draft Final Feasibility Study (SAIC 1996b), a landfill cap has been placed over the Demolition Landfill (Study Area 22) to reduce infiltration and migration of contaminants present in the soils at this study area.

PCBs were detected in the surface soil near transformers located in Study Area 2 (Smokeless Powder Facility). Screening samples collected around all transformers and former transformer buildings identified a potential PCB source from two of the transformers. A sufficient number of screening samples were collected to fully characterize the vertical and horizontal extent of contamination. Laboratory samples collected from these areas verified the presence of PCBs. Excavation and disposal of the PCB contaminated soils has occurred since the Phase 1 Supplemental RI.

PAHs were identified as human health COCs in the soil for the industrial and construction land uses at Study Areas 2 and 22. PAHs are byproducts of combustion and many of the structures in Area B were demolished by burning. As stated above, Study Area 22 (Demolition Landfill) has been capped since the collection of soil samples during the Phase 1 Supplemental RI. PAHs were also identified as human health COCs in the soil for the residential land use at Study Areas 8 and 16.

Several metals were ecoCOCs in surface soil with HQs >1. For example, lead was detected in soils at concentrations resulting in HQs exceeding 1 at numerous study areas, including Study Areas 2, 3, 4, 6, 7, 8, 10 East, 10 West, 16, and 22; the Coke Oven; and the Pesticide and Fertilizer Storage Building. Aluminum also was detected in the surface soil at a number of study areas at concentrations that resulted in HQs > 1. These study areas included Study Areas 2, 4, 8, 16, 17, and 20; the Coke Oven; and the Pesticide and Fertilizer Storage Building. Study Areas 2, 3, 8, 16, 17, 18, 20, 22, and 25; the Coke Oven; and the Pesticide and Fertilizer Storage Building had four or

more metal ecoCOCs with HQs >1. A summary of the ecoCOCs identified in the soils is presented in Tables 8-5 and 8-6.

8.2.3 Sediments and Surface Water

Sediment samples were field screened and analyzed for explosives, but only a few samples exceeded the field screening criteria of 30 µg/g (protective of TNT exposures to a resident). Based on these results, confirmatory samples were placed at regular intervals along the ditches to determine if other target analytes were present.

Sediments sampled from surface water bodies, drainage channels, and ditches within Area B contain a variety of chemical constituents, including explosives, metals, VOCs, and SVOCs. Study Area 21 (Red Water Ditch) carried process wastewaters from the manufacturing areas and contained the most abundant number of contaminants (1,3,5-TNB, TNT, 2,4-DNT, 2-A-4,6-DNT, 4-A-2,6-DNT, and tetryl; 17 metals above background concentrations; and various VOCs and SVOCs). Explosives were detected at low concentrations at various locations along the Red Water Ditch. The highest concentrations of metals were detected in the northern tributary to the Red Water Ditch, near Study Area 8 (Acid/Organic Manufacturing Area) and at locations below Study Area 5 (Red Water Storage Basin). In the human health risk assessment, the only COC identified was iron in the Study Area 9 (Aniline Sludge Basin) sediment under a residential land use scenario. None of the chemicals was identified as a COC under the future industrial or construction land use scenarios. Eight metals, acetone, and five PAHs were identified as ecoCOCs with HQs >1 in sediment at one or more study area. **Table 8-7** combines the sediment ecoCOCs with the human health COCs for the most conservative land use and **Table 8-8** presents the sediment ecoCOCs for the likely future land use. There are no human health COCs in sediment under the likely future land use.

Surface water bodies located at Area B of ALAAP, including Study Area 9 (Red Water Storage Basin), Study Area 21 (Red Water Ditch), Study Area 26 (Crossover Ditch), Study Area 27 (Beaver Pond Drainage System) and a marshy area north of Study Area 16 (Flashing Ground), contain a variety of metals at concentrations above background. Explosives (including 2,4-DNT, 2,6-DNT, TNT, 2-A-4,6-DNT, 4-A-2,6-DNT, nitrobenzene, and isomers of nitrotoluene) were detected in the surface water within the Beaver Pond Drainage System. The source of explosives is attributed to the nearby TNT Manufacturing Areas. No COCs for human health (metals or explosives) were identified in surface water under any land use scenario. However, under the most conservative land use scenario (residential), COCs for ingesting fish were identified at two study areas: arsenic and Aroclor 1254 in fish from Study Area 21 (Red Water Ditch) and mercury in fish from Study Area 26 (Crossover Ditch). Seven metals and carbon disulfide were identified as ecoCOCs with HQs >1 in surface water at one or more study areas. **Table 8-9** combines the surface water ecoCOCs with the human health COCs (in fish tissue) for the most conservative land use and **Table 8-10** presents the surface water ecoCOCs for the likely future land use. There are no human health COCs in surface water or fish tissue under the likely future land use.

Table 8-7. COCs in Sediment for the Most Conservative Land Use
Alabama Army Ammunition Plant, Childersburg, Alabama

Constituent in Sediment	Study Area						
	5	9	21	26	27	TA	CO
Inorganics							
Arsenic							
Chromium							
Copper							
Iron		■					
Lead							
Manganese							
Mercury							
Nickel							
Zinc							
Organics							
Acetone							
Benzo(g,h,i)perylene							
Benzo(k)fluoranthene							
Chrysene							
Indeno(1,2,3-cd)pyrene							
Pyrene							

COCs are the chemicals of concern identified in the human health and ecological risk assessment.
The most conservative land use is residential.
TA - Talladega Creek
CO - Coosa River
Designators are as follows:

■ COC for humans
□ COC for ecological receptors

Table 8-8. COCs in Sediment for the Likely Land Use
Alabama Army Ammunition Plant, Childersburg, Alabama

Constituent in Sediment	Study Area						
	5	9	21	26	27	TA	CO
Inorganics							
Arsenic							
Chromium							
Copper							
Lead							
Manganese							
Mercury							
Nickel							
Zinc							
Organics							
Acetone							
Benzo(g,h,i)perylene							
Benzo(k)fluoranthene							
Chrysene							
Indeno(1,2,3-cd)pyrene							
Pyrene							

COCs are the chemicals of concern identified in the ecological risk assessment.
All COCs for sediment are for ecological exposures.
Likely land use is industrial/construction.
TA - Talladega Creek
CO - Coosa River
Shaded cell indicates an ecological COC for sediment.

Table 8-9. COCs in Surface Water/Fish Tissue for the Most Conservative Land Use
Alabama Army Ammunition Plant, Childersburg, Alabama

Constituent in Surface Water	Study Area						
	9	16	21	26	27	TA	CO
Inorganics							
Aluminum							
Arsenic			■				
Barium							
Cobalt							
Copper							
Iron							
Lead							
Manganese							
Mercury				■			
Organics							
Aroclor 1254			■				
Carbon disulfide							

COCs are the chemicals of concern identified in the human health and ecological risk assessment.
The most conservative land use is residential.
TA - Talladega Creek
CO - Coosa River
Designators are as follows:

■ COC in fish tissue for humans
□ COC for ecological receptors

Table 8-10. COCs in Surface Water for the Likely Land Use
Alabama Army Ammunition Plant, Childersburg, Alabama

Constituent in Surface Water	Study Area						
	9	16	21	26	27	TA	CO
Inorganics							
Aluminum							
Barium							
Cobalt							
Copper							
Iron							
Lead							
Manganese							
Organics							
Carbon disulfide							

COCs are the chemicals of concern identified in the ecological risk assessment.
All COCs for surface water are for ecological exposures.
Likely land use is industrial/construction.
TA - Talladega Creek
CO - Coosa River
Shaded cell indicates an ecological COC for surface water.

8.3 REMEDIAL GOAL OPTIONS

Remedial goal options (RGOs) are cleanup goals designed to be protective of human health and the environment and were calculated for the human health and ecological COCs (ecoCOCs). The human health RGOs (HHRGOs), ecological RGOs (ecoRGOs), and ARARs are all considered in the selection of the final cleanup levels. The final cleanup levels will be selected in the Feasibility Study (FS) and remediation at the site will be conducted to meet these levels.

RGOs for the protection of human health were calculated in accordance with EPA Region IV guidance (EPA 1995c) using an equation that is similar to the intake equation (Section 6.2.4.1), setting the cancer risk or noncancer HI to the desired target, and solving the equation for the concentration term. RGOs were developed using cancer target risks of 1×10^{-6}, 1×10^{-5}, and 1×10^{-4}, and using noncancer target HQs of 0.1, 1, and 3. This provides multiple RGOs for a given chemical. This discussion focuses on RGOs corresponding to a target cancer risk of 1×10^{-4} and a target HQ of 1. RGOs for protection of ecological receptors are focused on the COCs associated with the greatest ecological risk. Based on professional judgment regarding uncertainties in the HQs and the resulting significance of the findings, ecological RGOs were developed only for COCs whose HQs exceeded 10 and those with HQs > 1 that also exceeded ARARs. It is important to note that uncertainty is also associated with the RGOs. Because the RGO calculations are essentially the same as the risk calculations, the same uncertainty in the exposure assessment, the toxicity assessment, and the risk characterization is associated with the RGO calculations.

For a given chemical, multiple RGOs were calculated corresponding to different land uses and groups of ecological species considered for protection. For human health, RGOs are provided for both the likely land use scenarios (i.e., industrial and construction) and the most conservative land use scenario (i.e., residential). Industrial land use is the intended future land use of Area B according to the Site Management Plan prepared by the U.S. Army Environmental Center (USAEC) for ALAAP (USAEC 1995b). Because future industrial use of the land could require construction of buildings or other structures, the construction scenario was included as one of the likely land use scenarios. For ecological effects, the RGOs (ecoRGOs) for soil correspond to the lower of the RGOs for protection of non-mobile soil dwelling receptors (e.g., plants and earthworms) or mobile non-soil dwelling receptors (e.g., birds and rabbits). The lower of the two ecoRGOs is protective of both receptor groups. The ecoRGOs for sediment are single concentrations judged to be protective of sediment-dwelling biota, and ecoRGOs for surface water are concentrations judged to be protective of aquatic biota. The human health and ecoRGOs are listed in **Table 8-11**.

Table 8-11. Human Health and Ecological Remedial Goal Options Alabama Army Ammunition Plant, Childersburg, Alabama

Chemical	Human Receptor		Ecological Receptor	
	Industrial/ Construction Worker[a]	Resident	Soil Dwellers (plants and earthworms)	Non-soil Dwellers (mammals and birds)
Soil (mg/kg)				
Aluminum	–	–	22,500	13,400
Antimony	120/53	21	–	–
Arsenic	274/62	23	13	36
Cadmium	–	–	3	5
Chromium	773/366[b]	137[b]	84	23
Copper	–	–	320	127
Iron	345,789/59,113	21,991	–	–
Lead	–[c]	400[c]	50	320
Mercury	–	–	0.2	0.05
Manganese	2,225/1,431	403	–	–
Nickel	28,595/4,076	1,508	30	428
Vanadium	–	–	72	64
Zinc	–	–	451	37
2,4,6-Trinitrotoluene	348/89	33	–	–
2,4-Dinitrotoluene	356/373	73	21	4
Aroclor-1248	125/329	25	–	–
Aroclor-1254	18/8	1.4	–	–
Aroclor-1260	125/329	25	–	–
Benzo(a)anthracene	165/734	49	–	–
Benzo(a)pyrene	17/73	4.9	–	–
Benzo(b)fluoranthene	165/734	49	–	–
Benzo(g,h,i)perylene	165/734	49	–	–
Benzo(k)fluoranthene	1,652/7,342	489	–	–
Chrysene	12,931/13,041	1,772	–	–
Dibenzo(a,h)anthracene	17/73	4.9	–	–
Indeno(1,2,3-cd)pyrene	165/734	49	–	–
N-Nitrosodiphenylamine	20,709/102,528	6,952	–	–
Sediment (mg/kg)				
Aluminum	–	–	15,900	
Arsenic	–	–	504	
Cadmium	–	–	1.2	
Chromium	–	–	81	
Copper	–	–	34	
Iron	–	–	83,200	
Lead	–	–	47	
Mercury	–	–	0.15	
Molybdenum	–	–	ND	

Table 8-11. Human Health and Ecological Remedial Goal Options Alabama Army Ammunition Plant, Childersburg, Alabama

Chemical	Human Receptor		Ecological Receptor	
	Industrial/ Construction Worker[a]	Resident	Soil Dwellers (plants and earthworms)	Non-soil Dwellers (mammals and birds)
Surface Water (µg/L)				
Aluminum	–	–	87	
Barium	–	–	70	
Cobalt	–	–	62	
Copper	–	–	11	
Iron	–	–	1,000	
Lead	–	–	3	
Manganese	–	–	3,350	
Zinc	–	–	110	
Groundwater (µg/L)				
Antimony	–	6.3	–	
Arsenic	–	4.5	–	
Iron	–	4,693	–	
Lead	–	15[d]	–	
Manganese	–	375	–	
Thallium	–	1.3	–	
2-Amino-4,6-Dinitrotoluene	–	9.9	–	
4-Amino-2,6-Dinitrotoluene	–	9.9	–	
Benzo(a)pyrene	–	0.92	–	
Benzo(b)fluoranthene	–	9.2	–	
bis(2-Ethylhexyl)phthalate	–	313	–	
2,4-Dinitrotoluene	–	9.9	–	
2,6-Dinitrotoluene	–	9.9	–	
Nitrobenzene	–	7.8	–	
Pentachlorophenol	–	56	–	
RDX	–	47	–	
2,4,6-Trinitrotoluene	–	7.8	–	
Vinyl chloride	–	3.5	–	

– Analyte is not a COC.

a RGOs are based on a target HI of 1 or cancer risk of 1×10^{-4}. The RGO presented is the more stringent of the carcinogenic and noncarcinogenic RGO, if both were calculated. For soil, both the industrial and construction RGOs are shown because the RGOs for the industrial worker do not apply to COCs in subsurface soil.

b Conservatively assumes that all chromium is in the hexavalent form.

c The residential RGO for lead in soil is the EPA soil screening level (EPA 1994a). RGOs for the workers will be presented in the Feasibility Study.

d The residential RGO for lead in groundwater is the EPA action level in drinking water (EPA 1995c).

9. REFERENCES

Ables, E.D. 1969. "Home Range Studies of Red Foxes (Vulpes vulpes)." Journal of Mammalogy 50: 108-120.

Ables, E.D. 1974. "Ecology of the Red Fox in North America." In Fox, M.W., ed., The Wild Canids. New York, New York. Van Nostrand Reinhold. pp. 148-163.

Adamcik, R.S., et al. 1979. "Demographic and Dietary Responses of Red-tailed Hawks During a Snowshoe Hare Fluctuation." Canadian Field Naturalist 93: 16-27.

Althoff, D.P., and G.L. Storm. 1989. "Daytime Spatial Characteristics of Cottontail Rabbits in Central Pennsylvania." Journal of Mammalogy 70: 820-824.

Ambrose, R.E., C.R. Hinkle, and C.R. Wenzel. 1983. Best Current Practices for Protecting and Enhancing Fish and Wildlife on Coal Surface Mined Land in Central and Southern Appalachia. U.S. Fish and Wildlife Service, FWS/OBS-83/08.

Andersen, D.E., and O.J. Rongstad. 1989. "Home-range Estimates of Red-tailed Hawks Based on Random and Systematic Relocations." J. Wildlife Management 53: 802-807.

Arnold, T.W., and E.K. Fritzell. 1987. "Food Habits of Prairie Mink During the Waterfowl Breeding Season." Canadian Journal of Zoology 65: 2322-2324.

ASTM (American Society for Testing and Materials). 1994. "Standard Guide for Conducting Sediment Toxicity Test with Freshwater Invertebrates, E: 1383." In 1994 Annual Book of ASTM Standards. Volume 11.045. ASTM, Philadelphia, Pennsylvania. pp. 1196-1225.

ATSDR (Agency for Toxic Substances and Disease Registry). 1989. Toxicological Profile for 2-4 Dinitrotoluene and 2,6-Dinitrotoluene. Agency for Toxic Substances and Disease Registry, U.S. Public Health Service, Atlanta, Georgia.

Baes, C.F., R.D. Sharp, A.L. Sjoreen, and R.W. Shor. 1986. A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture. ORNL-5786. Martin Marietta Energy Systems, Oak Ridge, Tennessee.

Barnthouse, L.W., G.W. Suter, II, S.M. Bartell, J.J. Beauchamp, R.H. Gardner, E. Linder, R.V. O'Neill, and A.E. Rosen. 1986. User's Manual for Ecological Risk Assessment. ORNL-6251, ESD/2679. Martin Marietta Energy Systems, Inc., Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Bearce, D.N. 1978. "Structure of the Eastern Coosa Valley," American Journal of Science, v. 278. pp. 461-476.

Beyer, W.N., E. Conner, and S. Gerould. 1994. "Estimates of Soil Ingestion by Wildlife." J. Wildl. Mange. 58: 375-382.

Birks, J.D., and I.J. Linn. 1982. Studies of Home Range of the Feral Mink, Mustela Vison. Symposium of the Zoological Society of London 49: 231-257.

Bohall, P.G., and M.W. Collopy. 1984. "Seasonal Abundance, Habitat Use, and Perch Sites of Four Raptor Species in North-central Florida." J. Field Ornithology 55: 181-189.

Bouwer, H., and R.C. Rice. 1976. "A Slug Test Method for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells." Water Resources Research, v. 12, no. 3. pp. 423-428.

Bowers, T.S., B.D. Beck, and H.S. Karam. 1994. "Assessing the Relationship Between Environmental Lead Concentrations and Adult Blood Lead Levels." Risk Analysis. 14(2): 183-189.

Burns, T.P., B.W. Cornaby, S.V. Mitz, and C.T. Hadden. 1998. "A Probabilistic Interpretation of the Quotient Method for Characterizing and Managing Risk to Ecological Receptors." In Hoddinott, K.B., ed. Superfund Risk Assessment in Soil Contamination Studies: Third Volume, ASTM 1338, American Society of Testing and Materials, West Conschohocken, Pennsylvania.

Burrows, E.P., D.H. Rosenblatt, W.R. Mitchell, and D.L. Parmer. 1989. Organic Explosives and Related Compounds: Environmental and Health Considerations. U.S. Army Biomedical Research and Development Laboratory, Fort Detrick, Frederick, Maryland. March.

Burt, W.H., and R.P. Grossenheider. 1976. Peterson Field Guides: Mammals. Boston, Massachusetts. The Houghton Mifflin Company.

Causey, L.V. 1965. Availability of Ground Water in Talladega County, Geological Survey of Alabama, Division of Water Resources Bulletin 81. 63p.

CCC (Childersburg Chamber of Commerce). 1990. Census Data.

CCC. 1995. Sylacauga Alabama Community Profile and Childersburg Population Facts.

Chapman, J.A., and G.A. Feldhamer. 1982. Wild Mammals of North America. Baltimore, Maryland. The Johns Hopkins University Press.

Chappell, W.R. 1992. Scaling Toxicity Data Across Species. Environ. Geochem. Health 14:71-80.

Clayton, G.D., and F.E. Clayton (eds). 1981. Patty's Industrial Hygiene and Toxicology, Vol. 2C: Toxicology, 3rd Revised Edition. New York, New York. John Wiley & Sons.

Cockerham, L.G., and B. S. Shane (eds.). 1994. Basic Environmental Toxicology, CRC Press, Inc., Lewis Publishers. Boca Raton, Florida.

Cooper, H.H., J.D. Bredehoeft, and S.S. Papadopoulos. 1973. Response of a Finite-Diameter Well to an Instantaneous Charge of Water, Water Resources Research, 1973, v. 3, no. 1. pp. 263-269.

Cotton, J.A., L.A. Dugan, G.L. Hickman, and C.F. Montgomery. 1974. Soil Survey of Talladega County, U.S. Department of Agriculture, Soil Conservation Service. 101p.

Craighead, J.J., and F.C. Craighead. 1956. Hawks, Owls, and Wildlife. The Stackpole Co., Harrisburg, Pennsylvania, and Wildlife Management Institute, Washington, DC.

DA (U.S. Department of the Army). 1978. Installation Assessment of Alabama Army Ammunition Plant, Records Evaluation Report No. 130.

Decisioneering, Inc. 1993. Crystal Ball® (incorporates the forecasting tool into the Microsoft Excel spreadsheet application). Version 3.0. Boulder, Colorado.

Dilley, J.V., C.A. Tyson, R.J. Spanggord, D.P. Sasmore, G.W. Newell, and J.C. Dacre. 1982. Short-term Oral Toxicity of 2,3,6-Trinitrotoluene in Mice, Rats, and Dogs. J. Toxicol. Environ. Health. 9:565-585.

DOE (U.S. Department of Energy). 1989. Formerly Utilized Sites Remedial Action Program (FUSRAP). Letter to the Department of the Army. October.

Dowd, E., and L.D. Flake. 1985. "Foraging Habitats and Movements of Nesting Great Blue Herons in a Prairie River Ecosystem." South Dakota Journal of Field Ornithology. 56: 379-387.

Dragun, J. 1988. The Soil Chemistry of Hazardous Materials.

Dresen, T.E. 1991. ROD for Alabama Army Ammunition Plant Stockpile Soils Area Operable Unit. December.

Dwyer, T.J., G.F. Sepik, E.L. Derleth, et al. 1988. Demographic Characteristics of Maine Woodcock Population and Effects of Habitat Management. U.S. Fish and Wildlife Service Resource Report 4, Washington, DC.

Eary, L.E., and D. Rai. 1989. "Kinetics of Chromate Reduction by Ferrous Ions Derived from Hematite and Biotite at 25° C." Am. J. Sci. Vol. 289. pp. 180-213.

ECC (Environmental Chemical Corporation). 1998. Closure Report. Excavated Lead Contaminated Soil Areas 16 & 19 at Alabama Army Ammunition Plant, Childersburg,

Alabama. Prepared for U.S. Army Engineer District, Mobile, Alabama. Contract No. DACW01-95-0033, Task Order No. 0019.

ECC. 1999. Final Report. Cleanup of Coal Tar, Aniline Sludge Basin at Alabama Army Ammunition Plant, Childersburg, Alabama. Prepared for the U.S. Army Engineer District, Mobile, Alabama. Contract No. DACW01-95-D-0033, Task Order No. 0021.

ESE (Environmental Science and Engineering, Inc.). 1996. Land Reuse Plan for Alabama Army Ammunition Plant. August.

Eisler, R. 1987a. Mercury Hazards to Fish, Wildlife, and Invertebrates; A Synoptic Review. Biological Report 85 (1.10), U.S. Fish and Wildlife Service, Patuxent Wildlife Research. Laurel, Maryland.

Eisler, R. 1987b. Polycyclic Aromatic Hydrocarbon Hazards to Fish, Wildlife, and Invertebrates; A Synoptic Review. Biological Report 85 (1.11), U.S. Fish and Wildlife Research. Laurel, Maryland.

Ellis, H.V., III, J.H. Hagensen, J.R. Hodgson, J.L. Minor, C-B. Hong, E.R. Ellis, J.D. Girvin, D.O. Helton, B.L. Herndon, and C-C Lee. 1979. Mammalian Toxicity of Munitions Compounds. Phase III: Effects of Lifetime Exposure. Part 1: 2,4-Dinitrotoluene. Final Report No. 7. Midwest Research Institute. Kansas City, Missouri. Contract No. DAMO 17-74-C-4073, ADA077692.

Endangered Species Act 16 U.S.C. §§ 1531-1544 (1993, as amended).

Environmental Laboratory. 1987. U.S. Army Corps of Engineers Wetland Delineation Manual. Technical Report Y-87-1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. 100p. plus appendices.

EPA (U.S. Environmental Protection Agency). 1983. Methods for Chemical Analysis of Water and Wastes.

EPA. 1985. Health Assessment Document for Trichloroethylene. Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Research Triangle Park, North Carolina. EPA 600/8-82-006F. July.

EPA. 1987a. Compendium of Superfund Field Operations Methods.

EPA. 1987b. Health Assessment Document for Trichloroethylene Addendum. Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Research Triangle Park, North Carolina. EPA 600/8-82-006FA. June.

EPA. 1987c. Data Quality Objectives for Remedial Response Activities, Development Process, Office of Emergency and Remedial Response and Office of Waste Program Enforcement. EPA/540/G-87/003. March.

EPA. 1988a. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA.

EPA. 1988b. Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses.

EPA. 1989a. Risk Assessment Guidance for Superfund: Human Health Evaluation Manual (Part A). Office of Solid Waste and Emergency and Remedial Response. OSWER Directive 9285.701A.

EPA. 1989b. Exposure Factors Handbook. Office of Health and Environmental Assessment. EPA/600/8-89/043.

EPA. 1989c. Statistical Analysis of Ground-water Monitoring Data at RCRA Facilities. Interim Final Guidance. Office of Solid Waste, Waste Management Division. EPA/530/SW-89/026.

EPA. 1989d. Risk Assessment Guidance for Superfund, Volume II: Environmental Evaluation Manual. (RAGS Vol. II), Washington, DC. EPA/540/1-89/001.

EPA. 1989e. Ecological Assessments of Hazardous Waste Sites: A Field and Laboratory Reference Document. EPE/600/E-89/013.

EPA. 1989f. Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms. Environmental Monitoring Systems Laboratory, Cincinnati, Ohio. EPA/600/4-89/001. 262p.

EPA. 1989g. Risk Assessment Guidance for Superfund (RAGS), Volume II: Environmental Evaluation Manual. EPA/540/1-89-001. U.S. Environmental Protection Agency.

EPA. 1991a. Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. Office of Emergency and Remedial Response, OSWER Directive 9285.6-03.

EPA. 1991b. Risk Assessment Guidance for Superfund: Volume 1 – Human Health Evaluation Manual (Part B): Development of Risk-based Preliminary Remediation Goals. EPA Office of Emergency and Remedial Response.

EPA. 1991c. National Oil and Hazardous Substances Pollution Contingency Plan. Part 300, Subpart E.

EPA. 1991d. Environmental Compliance Branch Operating Procedures and Quality Assurance Branch. U.S. Environmental Protection Agency Region IV, Environmental Services Division. February 1.

EPA. 1991e. "Ecological Assessment of Superfund Sites: An Overview" ECOUpdate 1(2), Office of Solid Waste and Emergency Response, Publ. 9345.0-051.

EPA. 1991f. Soil Transport and Fate (STF) Database and Model Management System, ver. 2.0. R.S. Kerr Environmental Research Laboratory, Ada, Oklahoma.

EPA. 1992a. Dermal Exposure Assessment: Principles and Applications. Office of Health and Environmental Assessment. EPA/600/8-91/001B.

EPA. 1992b. Risk Assessment Guidance for Superfund, Volume 1. Human Health Evaluation Manual, Supplemental Guidance, Dermal Risk Assessment, Interim Guidance Draft, U.S. Environmental Protection Agency. August 18.

EPA. 1992c. Statistical Analysis of Ground-water Monitoring Data at RCRA Facilities. Addendum to Interim Final Guidance. Office of Solid Waste, Permits and State Programs Division.

EPA. 1992d. Risk Assessment Issue Paper for Provisional RfD for Trichloroethylene (CASRN 79-01-6). Draft. Environmental Criteria and Assessment Office.

EPA. 1992e. Guidelines for Exposure Assessment: Notice. Federal Register. Volume 57, Number 104, 22888-22938. May 29.

EPA. 1992f. Framework for Ecological Risk Assessment. Risk Assessment Forum, 630/R-92/001. Washington, DC.

EPA. 1992g. Supplemental Guidance to RAGS: Calculating the Concentration Term. Office of Emergency and Remedial Response, Hazardous Site Evaluation Division, Washington, DC. Interim Bulletin, Vol.1, No.1, OSWER 9285.7-081.

EPA. 1993a. Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure. Preliminary Review Draft. May 5.

EPA. 1993b. Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons. Office of Research and Development. EPA/600/R-93/089.

EPA. 1993c. Risk Reduction Engineering Laboratory (RREL) Treatability Database, Version 4.0. Office of Research and Development, Cincinnati, Ohio.

EPA. 1993d. Technical Basis for Deriving Sediment Quality Criteria for Nonionic Organic Contaminants for the Protection of Benthic Organisms by Using Equilibrium Partitioning. EPA-822-R-93-011, Office of Water, Washington, DC. September.

EPA. 1993e. Water Quality Guidance for the Great Lakes System and Correction: Proposed Rules. Federal Register. 58(72): 20802-21047.

EPA. 1993f. Wildlife Exposure Factors Handbook. EPA/600/R-93/187A,B. Office of Research and Development, Washington, DC.

EPA. 1994a. Soil Screening Guidance. Office of Solid Waste and Emergency Response. EPA/540/R-94/101. December.

EPA. 1994b. Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities. Office of Solid Waste and Emergency Response. OSWER Directive #9355.4-12.

EPA. 1994c. LEAD 0.99d. A PC Software Application of the Uptake/Biokinetic Model for Lead, Version 0.99d. March 8.

EPA. 1994d. Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children. Office of Solid Waste and Emergency Response. EPA/540/R-93/081. February.

EPA. 1995a. National Sediment Inventory: Documentation of Derivation of Freshwater Sediment Quality. Office of Water, Washington, DC.

EPA. 1995b. Health Effects Assessment Summary Tables, FY-95 Annual. Office of Research and Development. Office of Solid Waste and Emergency Response. EPA/540/R-95/036. May.

EPA. 1995c. Supplemental Guidance to RAGS: Region IV Bulletins (Data Collection and Evaluation, Toxicity Assessment, Exposure Assessment, Risk Characterization, Development of Risk-Based Remedial Options). Interim Draft, Office of Technical Services, Atlanta, Georgia. September.

EPA. 1995d. EPA Region III Risk-Based Concentration Table, January – June 1995. Technical Support Section, Philadelphia, Pennsylvania. March.

EPA. 1995e. Drinking Water Regulations and Health Advisories. Office of Water. May.

EPA. 1995f. Water Quality Criteria Summary. Draft. Office of Science and Technology, Health and Ecological Criteria Division.

EPA. 1996a. Exposure Factors Handbook, Volume I, General Factors. EPA/600/P-95/002Fa. Office of Research and Development. Washington, DC. August

EPA. 1996b. Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil. Technical Review Workgroup for Lead. December.

EPA. 1997a. Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments. Interim Final. U.S. EPA Env. Response Team. Edison, New Jersey. June.

EPA. 1997b. Health Effects Assessment Summary Tables, FY-97 Update. Office of Research and Development, Office of Solid Waste and Emergency Response. EPA/540/R-97-036.

EPA. 1998a. Risk Assessment Guidance for Superfund: Volume I—Human Health Evaluation Manual (Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments). Office of Solid Waste and Emergency Response. EPA/540/R-97-033.

EPA. 1998b. EPA Region III Risk-Based Concentration Table. October. Update. EPA Region III website (www.epa.gov/reg3hwmd/riskmenu.htm).

EPA. 1999. Integrated Risk Information System (IRIS). U.S. Environmental Protection Agency On-line Database of Toxicity Measures. Office of Research and Development, Environmental Criteria and Assessment Office, Cincinnati, Ohio. Electron Mail Account Information via TOXNET, National Library of Medicine, Bethesda, Maryland.

ESE (Environmental Science and Engineering). 1981. Environmental Survey of Alabama Army Ammunition Plant, Final Report for Period September 1979-October 1980. Report No. DRXTH-FS-CR-81104. July.

ESE. 1983. Confirmatory Environmental Survey, Alabama Army Ammunition Plant. Final Report. Prepared for U.S. Army Toxic and Hazardous Materials Agency. June.

ESE. 1986. Alabama Army Ammunition Plant Remedial Investigation Final Report. Prepared for U.S. Army Environmental Center, Aberdeen Proving Ground, Maryland. Contract No. DAAK11-83-D-0007, Task Order 0008, Delivery Order 0008. July.

ESE. 1987. Alabama Army Ammunition Plant Feasibility Study. Final Report. November.

ESE. 1991a. Remedial Investigation/Feasibility Study (RI/FS) of the Industrial Sewer System, Alabama Army Ammunition Plant. September.

ESE. 1991b. Supplemental Remedial Investigation/ Feasibility Study (RI/FS) for Area B Alabama Army Ammunition Plant. Draft Final Remedial Investigation. Volume I. Prepared for U.S. Army Toxic and Hazardous Materials Agency.

ESE. 1991c. Stockpile Characterization Report for Alabama Army Ammunition Plant. January.

ESE. 1992. Supplemental Remedial Investigation/Feasibility Study (RI/FS) for Area B, Alabama Army Ammunition Plant, Final Baseline Risk Assessment. Volume I, II. August.

ESE. 1993. Supplemental Remedial Investigation/Feasibility Study (RI/FS) for Area B, Alabama Army Ammunition Plant, Final Remedial Investigation. Volume I, II. Prepared for: U.S. Army Environmental Center, Aberdeen Proving Ground, Maryland. Contract No. DAAA15-88-D-003, Delivery Order 0007. June.

ESE. 1995. Supplemental Remedial Investigation/Feasibility Study for Area A, Alabama Army Ammunition Plant Final Draft Remedial Investigation. Volume I. Prepared for U.S. Army Environmental Center, Aberdeen Proving Ground, Maryland. December.

ESE. 1996. Land Reuse Plan, Alabama Army Ammunition Plant. Prepared for U.S. Army Environmental Center, Aberdeen Proving Ground. Maryland. August.

Etnier, D.A., and W.C. Starnes. 1993. The Fishes of Tennessee. University of Tennessee Press, Knoxville, Tennessee. 681p.

FDA (U.S. Food and Drug Administration). 1997. Daily Reference Values and Reference Daily Intakes. FDA website (www.fda.gov//fdac/special/foodlabel/dvs.htm).

Fedoroff, B.T., H.A. Aaronson, O.E. Sheffield, G.D. Clift, and E.F. Reese. 1960. Encyclopedia of Explosives and Related Items. Volume I. Picatinny Arsenal. Dover, New Jersey.

Fitch, H.S., et al. 1946. "Behavior and Food Habits of the Red-tailed Hawk." Condor 48: 205-237.

Funk, S.B., D.J. Roberts, D.L. Crawford, and R.L. Crawford. 1993. "Initial-Phase Optimization, for Bioremediation of Munition Compound-Contaminated Soils." Applied and Environmental Microbiology 59(7): 2171-2177.

Geraghty and Miller. 1991. AQTESOLV®, Aquifer Test Solver, Computer Software Version 1.1, Revision 4. September 18.

Getz, L.L. 1989. A 14-year study of Blarina brevicauda. American Society of Mammalogists: Mammalian Species. 261p.

Gilbert, R.O. 1987. Statistical Methods for Environmental Pollution Monitoring. New York, New York. Von Nostrand Reinhold Company.

Gillette, J.W. 1983. "A Comprehensive Prebiological Screen for Ecotoxicological Effects." Environ. Toxicol. Chem. 2: 463-376.

Gregg, L. 1984. Population Ecology of Woodcock in Wisconsin. Wisconsin Department of Natural Resources. Technical Bulletin No. 144. 51p.

Guthrie, G.M. 1993. Photo-Lineament Map of Landsat Imagery, Alabama Piedmont, Alabama Geological Survey of Alabama, Special Map 239, 1 sheet.

Harkins, J.R. 1972. Surface-Water Availability, Talladega County, Alabama. Geological Survey of Alabama, Special Map 112.

HAZWRAP (Hazardous Waste Remedial Action Program). 1994. Ecological Risk Assessment Methodology for Loring Air Force Base. Draft.

Howard, P.H. 1990. Handbook of Environmental Fate and Exposure for Organic Chemicals. Chelsea, Michigan. Lewis Publishers, Inc.,

Howard, P.H., R.S. Boethling, W.F. Jarvis, W.M. Meylan, and E.M. Michalenko. 1991. Environmental Degradation Rates. Chelsea, Michigan. Lewis Publishers, Inc.,

Hull, R.N., and G.W. Suter, II. 1994. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Sediment-Associated Biota. Revision. ES/ER/TM-95/R1. Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Industrial Development Board of Childersburg (IDBC). 1997. Childersburg Industries Information.

Jenkins, T.F. 1990. Development of a Simplified Field Method for the Determination of TNT in Soil. Special Report 90-38. U.S. Army Corps of Engineers, Cold Regions Research & Engineering Laboratory. Prepared for USATHAMA, Report CETHA-TS-CR-90125. November.

Jones, D.S., G.W. Suter, II, and R.N. Hull. 1997. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota: 1997 Revision. ES/ER/TM-95/R4. Lockheed Martin Energy Systems, Inc. November.

Kaplan, D.L., and A.M. Kaplan. 1982a. "Thermophilic Biotransformation of 2,4,6-Trinitrotoluene under Simulated Composting Conditions." Applied and Environmental Microbiology 44(3): 757-760.

Kaplan, D.L., and A.M. Kaplan. 1982b. "Composting Industrial Wastes—Biochemical Consideration." BioCycle 23(3): 42-44.

Klidzijs, M.A. 1994. Distribution, Bedrock Control, and Geochemistry of Groundwater in the Knox Group in Parts of Talladega, St. Clair, and Shelby Counties, Alabama, Master of Science thesis submitted to Auburn University. 106p.

Kuhne, E.R. 1939. A Guide to the Fishes of Tennessee and the Mid-South. Tennessee Department of Conservation, Division of Fish and Game, Nashville, Tennessee.

Linscombe, G., et al. 1982. "Mink." In Chapman and Feldhammer, eds., Wild Mammals of North America. Baltimore, Maryland. John Hopkins University Press.

Long, E.R., and L.G. Morgan. 1991. The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program. National Oceanic and Atmospheric Administration Technical Memorandum NOS OMA 52. Seattle, Washington. August.

Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1994. "Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments." Environ. Management 19: 81-97.

Lord, K.A., G.G. Briggs, M.C. Neale, and R. Manlove. 1980. "Uptake of Pesticides from Water and Soil by Earthworms." Pesticide Science 11: 401-408.

Lyman, W.J., W.E. Roehl, and D.H. Rosenblatt. 1982. Handbook of Chemical Property Estimation Methods: Environmental Behavior of Organic Compounds.

Marshall, W.H. 1936. "A Study of the Winter Activities of the Min." Journal of Mammalogy 17: 382-292.

McCormick, N.G., J.H. Cornell, and A.M. Kaplan. 1978. "Identification of Biotransformation Products from 2,4-Dinitrotoluene." Applied and Environmental Microbiology 35(5): 945-948.

McGovern, M., and J.M. McNurney. 1986. "Densities of Red-tailed Hawks in Aspen Stands in the Piceance Basin, Colorado." Raptor Research 20: 43-45.

Migratory Bird Treaty Act 16 U.S.C. §§703-711 (1993, as amended).

Mills, W.B., D.B. Porcella, M.J. Ungs, S.A. Gherini, K.V. Summers, G.L. Rupp, and G.L. Bowie. 1985. Water Quality Assessment: A Screening Procedure for Toxic and Conventional Pollutants: Parts 1, 2, and 3. EPA Environmental Research Laboratory, Office of Research and Development, Athens, Georgia. EPA/600/6-85/002.

Mitchell, J.L. 1961. "Mink Movements and Populations on a Montana River." Journal of Wildlife Management 25: 48-54.

Moser, P.H. 1988. Groundwater Availability in Talladega County, Alabama. Geological Survey of Alabama Special Map 207.

Ng, Y.C. 1982. "A Review of Transfer Factors for Assessing the Dose from Radionuclides in Agricultural Products." Nuclear Safety. 23: 57-71.

NIOSH (National Institute for Occupational Safety and Health). 1992. Registry of Toxic Effects of Chemical Substances (RTECS). Searched online October 1992. Cincinnati, Ohio.

NLM (National Library of Medicine). 1992. Hazardous Substances Data Bank (HSDB) Toxicological Data Network (TOXNET), Bethesda, Maryland.

NOAA (National Oceanic and Atmospheric Administration). 1992. "Monthly Station Normals of Temperature, Precipitation, and Heating and Cooling Degree Days: 1961-90." Climatography of the United States No. 81. Alabama. James R. Owenby and D.S. Ezell. January.

NOAA. 1993. "Local Climatological Data Annual Summary for 1993." Abstract on Birmingham (Municipal Airport) Alabama. NOAA Central Library, Silver Spring, Maryland.

Ogata, A., and R.B. Banks. 1961. A Solution of the Differential Equation of Longitudinal Dispersion in Porous Media. U.S. Geological Survey, Professional paper 411-A. Reston, Virginia.

OGE (O'Brien & Gere Engineers, Inc.). 1988. Hazardous Waste Site Remediation.

Opresko, D.M., B.E. Sample, and G.W. Suter, II. 1994. Toxicological Benchmarks for Wildlife: 1994 Revision. ES/ER/TM-86/R1. Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Opresko, D.M., B.E. Sample, and G.W. Suter, II. 1995. Toxicological Benchmarks for Wildlife: 1995 Revision. ES/ER.TM-86/R2. Lockheed Martin Energy Systems, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Osborne, W.E. 1989. Stratigraphy and Structure of Part of the Pell City Thrust Sheet, Appalachian Fold-and-Thrust Belt, St. Clair, Talladega, and Calhoun Counties, Alabama: A Summary Report of Investigations for 1988-1989. Submitted to Southern Company Services, Inc. March. 13p.

Osborne, W.E., and N.W. Szabo. 1984. Stratigraphy and Structure of the Jacksonville Fault, Calhoun County, Alabama, Geological Survey of Alabama, circular 117.

Osborne, W.E., N.W. Szabo, C.W. Copeland, and T.L. Neathery. 1989. Geologic Map of Alabama, Alabama Geological Survey Special Map 221.

Parnell, J.F., and R.F. Soots. 1978. "The Use of Dredge Islands by Wading Birds." Wading Birds, National Audubon Society Resource Report 7: 105-111.

Perry, R.H., C.H. Chilton, and S.D. Kirkpatrick. 1969. Chemical Engineers Handbook. New York, New York. McGraw Hill Book Company.

Persaud, D., R. Jaagumagi, and A. Hayton. 1990. The Provincial Sediment Quality Guidelines. Ontario Ministry of the Environment.

Persaud, D., R. Jaagumagi, and A. Hayton. 1993. Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario. Ontario Ministry of the Environment. Water Resources Branch, Toronto, Ontario, Log 92-2309-067, PIBS 1962. August.

Petersen, L. 1979. "Ecology of Great Horned Owls and Red-tailed Hawks in Southeastern Wisconsin." Wisconsin Department of Natural Resources Technical Bulletin No. 111.

Planert, M., and J.L. Pritchett. 1989. Geohydrology and Susceptibility of Major Aquifers to Surface Contamination in Alabama; Area 4, U.S. Geological Survey Water-Resources Investigations Report 88-4133. 31p.

Platt, W.J. 1976. "The Social Organization and Territoriality of Short-tailed Shrew (Blarina brevicauda) Populations in Old-field Habitats." Animal Behavior 24: 305-318.

Quast, J.F., C.G. Humiston, R.Y. Kalnins, et al. 1979. Results of a Toxicity Study of Monomeric Styrene Administered to Beagle Dogs by Oral Intubation for 19 Months. Toxicology Research Laboratory, Health and Environmental Sciences, DOW Chemical Co., Midland, Michigan. Final Report.

Redwine, J.C. 1993. Logan Martin Dam Deep Grouting Program: Hydrogeologic Framework in Folded and Faulted Appalachian Karst, Applied Karst Geology. pp. 243-254.

Rheams, K.F. 1992. Mineral Resources of the Valley and Ridge Province, Alabama, Geological Survey of Alabama, Bulletin 147.

SAF (Society of American Foresters). 1980. F.H. Frye, ed. Forest Cover Types of the United States and Canada. Washington, DC.

SAIC (Science Applications International Corporation). 1995a. Final Supplemental Remedial Investigation/Feasibility Study Sampling and Analysis Plan/Work Plan. Alabama Army Ammunition Plant, Area B, Childersburg, Alabama. Prepared for the U.S. Army Environmental Center, Aberdeen Proving Ground, Maryland. May.

SAIC. 1995b. Final Quality Assurance Project Plan. Alabama Army Ammunition Plant, Area B, Childersburg, Alabama. Prepared for the U.S. Army Environmental Center, Aberdeen Proving Ground, Maryland. May.

SAIC. 1995c. Final Health and Safety Plan. Alabama Army Ammunition Plant, Area B, Childersburg, Alabama. Prepared for the U.S. Army Environmental Center, Aberdeen Proving Ground, Maryland. May.

SAIC. 1995d. SAIC Field Procedure FTP-971.

SAIC. 1996a. Draft Alabama Army Ammunition Plant – Area B Supplemental Remedial Investigation Report. Prepared for U.S. Army Environmental Center, Aberdeen Proving Ground, Maryland. February.

SAIC. 1996b. Alabama Army Ammunition Plant Area B Draft Final Feasibility Study Report. Prepared for U.S. Army Environmental Center, Aberdeen Proving Ground, Maryland. March.

SAIC. 1996c. Final Supplemental Remedial Investigation/Feasibility Study Sampling and Analysis Plan/Work Plan Addendum. Prepared for U.S. Army Environmental Center, Aberdeen Proving Ground, Maryland. June.

SAIC. 1996d. Final Supplemental Remedial Investigation/Feasibility Study Sampling and Analysis Plan/Work Plan Addendum 2. Prepared for U.S. Army Environmental Center, Aberdeen Proving Ground, Maryland. November.

SAIC. 1997. Final Work Plan Addendum for Phase 4 Investigations. Prepared for USACE, Mobile District. October.

SAIC. 1999. Draft Final Version 2 Alabama Army Ammunition Plant – Area B Supplemental Remedial Investigation Report. Prepared for USACE, Mobile District. April.

Sample, B.E., and G.W. Suter II. 1994. Estimating Exposure of Terrestrial Wildlife to Contaminants. ES/ER/TM-125. Martin Marietta Energy Systems, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Sample, B.E., D.M. Opresko, and G.W. Suter, II. 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. ES/ER/TM-86/R3. Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Shen, T.T., C.E. Schmidt, and T.R. Card. 1993. Assessment and Control of VOC Emissions from Waste Treatment and Disposal Facilities. New York, New York. Van Nostrand Reinhold.

Sheppard, M.I., and D.H. Thibault. 1990. "Default Soil Solid/Liquid Partition Coefficients for Four Major Soil Types: A Compendium." Health Physics. Vol. 59, No. 4. pp. 471-482.

Shuman, L.M. 1991. "Chemical Forms of Micronutrients in Soils." In J.J. Montvedt (ed.), Micronutrients in Agriculture. Soil Sci. Soc. Am. Book Series No. 4, Soil Sci. Soc. Amer., Inc., Madison, Wisconsin.

Southern Company Services. 1989. Logan Martin Hydrogeological Studies, Phase II Interim Report.

Summers, K., S. Gherini, and C. Chem. 1980. Methodology to Evaluate the Potential for Groundwater Contamination from Geothermal Fluid Release. EPA-600/7-80-117, as modified by U.S. EPA Region IV.

Suter, G.W., II, et al. 1993. "Compacted Soil Barriers at Abandoned Landfill Sites are Likely to Fail in the Long Term." J. Environ. Qual. 22: 217-226.

Suter, G.W., II, et al. 1994. Approach and Strategy for Performing Ecological Risk Assessments for the U.S. Department of Energy's Oak Ridge Reservation: 1994 Revision. ES/ER/TM-33/RI. Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Suter, G.W., II, M.E. Will, and C. Evans. 1993. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants. ES/ER/TM-85. Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Suter, G.W., II. 1993. Ecological Risk Assessment. Chelsea, Michigan. Lewis Publishers, p. 238.

Suter, G.W., II, and J.B. Mabrey. 1994. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1994 Revision. ES/ER/TM-96/R1. Martin Marietta Energy Systems, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Suter, G.W., II and C.L. Tsao. 1996. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revisions. ES/ER/TM-92/R2. Lockheed Martin Energy Systems, Inc., Oak Ridge, Tennessee.

Talmadge, S.S., and B.T. Walton. 1993. Food Chain Transfer and Potential Renal Toxicity of Mercury to Small Mammals at a Contaminated Terrestrial Field Site. Ecotoxicology 2: 243-256.

TETC (The Earth Technology Corporation). 1994. Community Environmental Response Facilitation Act (CERFA) Report, Alabama Army Ammunition Plant, Talladega County, Alabama. Prepared for U.S. Army Environmental Center. April.

Travis, C.C., and RK. White. 1988. Interspecific Scaling of Toxicity Data. Risk Analysis 8: 119-124.

Travis, C.C., and A.D. Arms. 1988. "Bioconcentration of Organics in Beef, Milk, and Vegetation." Environ. Sci. Technol. 22: 271-274.

Trent, T.T., and O.S. Rongstad. 1974. "Home Range and Survival of Cottontail Rabbits in Southwestern Wisconsin." Journal of Wildlife Management 38: 459-472.

U.S. Army Corps of Engineers (USACE). 1990. Development of a Simplified Field Method for the Determination of TNT in Soil. Special Report 90-38. Thomas F. Jenkins and Marianne E. Walsh. U.S. Army Corps of Engineers, Cold Regions & Engineering Laboratory. October.

USACE. 1991. Field Screening Method for 2,4-Dinitrotoluene in Soil. Special Report 91-17. Thomas F. Jenkins and Marianne E. Walsh. U.S. Army Corps of Engineers, Cold Regions & Engineering Laboratory. October.

USACE. 1994. Field Screening Method for TNT and RDX in Groundwater. Special Report 94-14. Thomas F. Jenkins and Marianne E. Walsh. U.S. Army Corps of Engineers, Cold Regions & Engineering Laboratory. October.

USACE. 1999. Alabama Army Ammunition Plant Remedial Actions. Partnering Conference Presentation by Ken Gray. February 16.

USAEC (U.S. Army Environmental Center). 1995a. Users Guide to Installation Restoration Data Management Information System (IRDMIS). Prepared by Potomac Research, Inc. (Edition 1995.1).

USAEC. 1995b. Site Management Plan, Alabama Army Ammunition Plant, Talladega County, Alabama. Prepared by the U.S. Army Environmental Center, Base Closure Division, Aberdeen Proving Ground, Maryland. May 10.

USATHAMA (U.S. Army Toxic and Hazardous Material Agency). 1978. Installation Assessment of Alabama Army Ammunition Plant, Report No. 130. Aberdeen Proving Ground, Maryland.

USATHAMA. 1987. Geotechnical Requirements for Drilling, Monitor Wells, Data Acquisition, and Reports.

USATHAMA. 1990. Quality Assurance Program. PAM 11-41. January.

USFWS (U.S. Fish and Wildlife Service). 1987. Preliminary Natural Resource Survey, Alabama Army Ammunition Plant. September.

USGS (U.S. Geological Survey). 1958. Topographic Map of Childersburg Quadrangle, Alabama, 7.5 minute single sheet. Photorevised in 1972.

USGS. 1994. The Water Resources Data, Alabama, Water Year 1994. USGS Water Data Report AL-94-1.

Van Genuchten, M. Th., and W.J. Alves. 1982. Analytical Solutions of the One-Dimensional Convective-dispersive Solute Transport Equation, U.S. Department of Agriculture, Technical Bulletin No. 1661. 151p.

Walsh, M.E. 1990. Environmental Transformation Products of Nitroaromatics and Nitramines, Special Report, U.S. Army Corps of Engineers. February.

Walsh, M.E., and T.F. Jenkins. 1992. Identification of TNT Transformation Products in Soil. Special Report 92-16. U.S. Army Corps of Engineers Cold Regions Research and Engineering Laboratory.

Wentsel, R.S., R.T. Checkai, T.W. LaPoint, M. Simini, D. Ludwig, and L. Brewer. 1994. Procedural Guidelines for Ecological Risk Assessments at U.S. Army Sites, Vol. 1. ERDEC-TR-221, Aberdeen Proving Ground, Maryland.

Wentsel, R.S., R.T. Checkai, T.W. La Point, M. Simini, D. Ludwig, and L. Brewer. 1996. Tri-Service Procedural Guidelines for Ecological Risk Assessment, Vol. 1. ERDEC-TR-221, Edgewood Development & Engineering Center, Aberdeen Proving Ground, Maryland.

Weston (Roy F. Weston, Inc.). 1991. Feasibility Study for the Alabama Army Ammunition Plant Soil Stockpile Area. October.

Weston. 1994a. Draft Interim Record of Decision, Alabama Army Ammunition Plant (ALAAP), Area B Soils Operable Unit. July.

Weston. 1994b. Excavation Plan for Area 21 (Red Water Ditch) at the Alabama Army Ammunition Plant (ALAAP), Childersburg, Alabama. Submitted to U.S. Army Corps of Engineers, Fort McClellan, Alabama.

Weston. 1994c. IROD Stockpile Soils. April.

Weston. 1994d. IROD, Alabama Army Ammunition Plant, Study Areas 6, 7, 10, and 21 of the Area B Soil Operable Unit. November.

Weston. 1995a. Monthly Status Report – Study Areas 7 and 21 and Excavation Plan for Study Area 7, Alabama Army Ammunition Plant, Childersburg, Alabama. Submitted to U.S. Army Corps of Engineers, Fort McClellan, Alabama. January.

Weston. 1995b. Excavation Plan for Study Area 21, Alabama Army Ammunition Plant, Childersburg, Alabama. Submitted to U.S. Army Corps of Engineers, Fort McClellan, Alabama. April.

Weston. 1996a. Excavation Status Report for Study Area 10 and Updated Excavation Volumes for Study Areas 6, 7, and 21. February.

Weston. 1996b. IROD for Area B Soils Operable Unit IV (Study Areas 2, 5, 8, 9, 10, 16, 17, 19, and 22). April.

Weston. 1996c. IROD for Area B Soils Operable Unit IV (Study Areas 2, 10, 16, 17, 19, and 22). October.

Weston. 1996d. Addenda to the Work Plan for a Transportable Incinerator System: Remediation of Contaminated Soils from Area B, Operable Unit IV, Study Areas 2, 16, 17, and 19 at the Alabama Army Ammunition Plant. October.

Weston. 1996e. Sampling Report: Study Areas 2 and 17. November.

Weston. 1996f. Study Areas 16 and 19 Sampling Report. March.

Whitten, Charlie. 1996. U.S. Army Corps of Engineers Waterways Experiment Station. Comments on Draft Final Report for Area B. March.

Will, M.E., and G.W. Suter, II. 1994a. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants: 1994 Revision. ES/ER/TM-5-R1. Martin Marietta Energy Systems, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Will, M.E., and G.W. Suter, II. 1994b. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process. ES/ER/TM-126. Martin Marietta Energy Systems, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Will, M.E., and G.W. Suter, II. 1995a. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants: 1995 Revision. ES/ER/TM-85/R2. Martin Marietta Energy Systems, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Will, M. E., and G. W. Suter, II. 1995b. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process. ES/ER/TM-126. Martin Marietta Energy Systems, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

ACRONYMS

µS/cm	microSiemens/cm
1,3,5-TNB	1,3,5-trinitrobenzene
2,4-DNT	2,4-dinitrotoluene
2,6-DNT	2,6-dinitrotoluene
2-A-4,6-DNT	2-amino-4,6-dinitrotoluene
ADEM	Alabama Department of Environmental Management
AF	Animal Fraction
AGS	Alabama Geological Survey
ALAAP	Alabama Army Ammunition Plant
ANOVA	Analysis of Variance
ARAR	Applicable or Relevant and Appropriate Requirement
ASPCS	Alabama State Plane Coordinate System
ASTM	American Society for Testing and Materials
AUF	Area Use Factor
AWQC	Ambient Water Quality Criteria
BAF	Bioaccumulation Factor
B2EHP	Bis(2-ethylhexyl)phthalate
BCF	Bioconcentration Factor
BK	Background
BRA	Baseline Risk Assessment
BERA	Baseline Ecological Risk Assessment
BLS	Below Land Surface
BRAC	Base Realignment and Closure
BTOC	Below Top of Casing
BW	Body Weight
CDC	Centers for Disease Control and Prevention
CEB	Chemical Exceeding Background
CEC	Cation Exchange Capacity
CERFA	Community Environmental Response Facilitation Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory Program
COC	Chemical of Concern
COPC	Chemical of Potential Concern
COPEC	Chemical of Potential Ecological Concern
CPOM	Coarse Particulate Organic Matter
Cr^{+6}	Hexavalent Chromium
CRAVE	Carcinogen Risk Assessment Verification Endeavor
CRDL	Contract Required Detection Limits
CRQL	Contract Required Quantitation Limits
CRF	Central Records Facility
CRL	Certified Reporting Limit

CSF	Cancer Slope Factor
CSM	Conceptual Site Model
CTE	Central Tendency Exposure
DA	U.S. Department of the Army
DBH	Diameter at Breast Height
DI	De-Ionized
DMAS	Dimethylaniline Sulfate
DNB	Dinitrobenzene
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DPA	Diphenylamine
DQO	Data Quality Objective
DRO	Diesel Range Organics
DV	Dietary Value
EA	EA Engineering
ECC	Environmental Chemical Corporation
ecoCOC	Ecological Chemical of Concern
ecoRGO	Ecological Remediation Goal Option
ED	Exposure Duration
EF	Exposure Factor
Eh	Oxidation-reduction Potential
ELCR	Excess Lifetime Cancer Risk
ELISA	Enzyme Linked Immunosorbent Assay
EPA	U.S. Environmental Protection Agency
EPC	Exposure Point Concentration
EPT	Ephemeroptera-Plecoptera-Trichoptera
ER	Effects Range
ERA	Ecological Risk Assessment
ER-L	Effects Range-Low
ER-M	Effects Range-Medium
ESA	Endangered Species Act
ESE	Environmental Science and Engineering, Inc.
FDA	U.S. Food and Drug Administration
FFA	Federal Facilities Agreement
f_{oc}	Fraction of Organic Carbon
FS	Feasibility Study
FTP	Field Technical Procedures
GC/MS	Gas Chromatography/Mass Spectrometry
GOCO	Government-owned/Contractor-operated
GPR	Ground Penetrating Radar
GPS	Global Positioning System
GSA	General Services Administration

HASP	Health and Safety Plan
HEAST	Health Effects Assessment Summary Tables
HHRGO	Human Health Remedial Goal Option
HI	Hazard Index
HMX	Cyclotetramethylenetetranitramine
HQ	Hazard Quotient
HR	Home Range
ICAP	Inductively Coupled Argon Plasma
ID	Identification
I.D.	Inside Diameter
IDW	Investigation-derived Waste
IEUBK	Integrated Exposure Uptake Biokinetic
IRDMIS	Installation Restoration Data Management Information System
IR_F	Food Ingestion Rate
IR_w	Water Ingestion Rate
IRIS	Integrated Risk Information System
IROD	Interim Record of Decision
ISS	Industrial Sewer System
K_d	Soil/water Partition Coefficient
K_H	Henry's Law Constant
KOH	Potassium Hydroxide
K_{oc}	Soil Adsorption Coefficient
K_{ow}	Octanol-Water Partition Coefficient
LCL	Lower Control Limit
LCS	Laboratory Control Sample
LOAEL	Lowest-Observable-Adverse-Effects Level
LOEC	Lowest-Observed-Effects Concentration
LT	Less Than
MCL	Maximum Contaminant Level
MDL	Method Detection Limit
MEK	Methyl Ethyl Ketone
MnC	Minvale Cherty Silt Loam
MS/MSD	Matrix Spike/Matrix Spike Duplicate
msl	Mean Sea Level
NAWQC	National Ambient Water Quality Criteria
NB	Nitrobenzene
NC	Nitrocellulose
NCP	National Oil and Hazardous Substances Contingency Plan
NEPA	National Environmental Policy Act
NO_3	Nitrates
NOAA	National Oceanic and Atmospheric Administration
NOAEL	No-Observable-Adverse-Effect Level
NPL	National Priorities List

NVGD	National Vertical Geodetic Datum
O.D.	Outside Diameter
ORD	Office of Research and Development
PACE	PACE Environmental Laboratories
PAH	Polycyclic Aromatic Hydrocarbon
PARCC	Precision, Accuracy, Representativeness, Comparability, and Completeness
PCB	Polychlorinated Biphenyl
PCH	Phenol/Carbolic Acid/Hydroxbenzene
PCP	Pentachlorophenol
PF	Plant Fraction
PID	Photoionization Detector
PNA	Polynuclear Aromatic Compound
PO_4	Phosphates
ppb	Parts per Billion
PPE	Personal Protective Equipment
ppm	Parts per Million
PRG	Preliminary Remediation Goal
psi	Pounds per Square Inch
PVC	Polyvinyl Chloride
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
QA/QC	Quality Assurance/Quality Control
RAGS	Risk Assessment Guidance for Superfund
RBC	Risk-Based Concentration
RBP	Rapid Bioassessment Protocol
RCRA	Resource Conservation and Recovery Act
Rd	Retardation Factor
RDA	Recommended Daily Allowance
RDX	Cyclotrimethylenetrinitramine
RfC	Reference Concentration
RfD	Reference Dose
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RGO	Remediation Goal Option
RME	Reasonable Maximum Exposure
RPD	Relative Percent Difference
ROD	Record of Decision
SAIC	Science Applications International Corporation
SARA	Superfund Amendments and Reauthorization Act
SAP	Sampling Analysis Plan
SCS	Soil Conservation Service
SDG	Sample Delivery Group

SDVB	Stryenedivinylbenzene
SERA	Screening Ecological Risk Assessment
SF	Soil Fraction
SMDP	Scientific/Management Decision Points
SOP	Standard Operating Procedure
SVOC	Semivolatile Organic Compound
SWMU	Solid Waste Management Unit
T&E	Threatened and Endangered
TBC	To Be Considered
TCA	Trichlorethane
TCE	Trichlorethene
TCLP	Toxicity Characteristics Leaching Procedure
TEF	Toxicity Equivalence Factor
tetryl	2,4,6-trinitrophenylmethylnitramine
TIC	Tentatively Identified Compound
TIS	Transportable Incineration System
TNT	2,4,6-Trinitrotoluene
TOC	Total Organic Carbon
TOHI	Target Organ Hazard Index
TPH	Total Petroleum Hydrocarbon
TRV	Toxicity Reference Value
TUF	Temporal Use Factor
UCL	Upper Confidence Limit
UCL_{95}	95 percent Upper Confidence Limit
UCRL	Upper Certified Reporting Limit
USACE	U.S. Army Corps of Engineers
USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
USAEC	U.S. Army Environmental Center
USACE/WES	U.S. Army Corps of Engineers/Waterways Experiment Station
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Society
UST	Underground Storage Tank
UTL	Upper Tolerance Limit
VCP	Vitrified Clay Pipe
VOC	Volatile Organic Compound
Weston	Roy F. Weston
WLI	Water Level Indicator
XQ	Exposure Quotient
XRF	X-ray Fluorescence

U.S. EPA REGION IV

SDMS

Unscannable Material Target Sheet

DocID: 10723543 Site ID: AL6210020008

Site Name: Alabama Army Ammunition Plant

Nature of Material:

Map:	☒	Computer Disks:	☐
Photos:	☐	CD-ROM:	☐
Blueprints:	☐	Oversized Report:	☐
Slides:	☐	Log Book:	☐

Other (describe): Monitoring Well Location Map

Amount of material: _____

* Please contact the appropriate Records Center to view the material *